TECHNOLOGIES
for Human Welfare and Community Services

Technology for Rural Development
Volume 2

COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH
RAFI MARG, NEW DELHI-110 001 (INDIA)
May 1984

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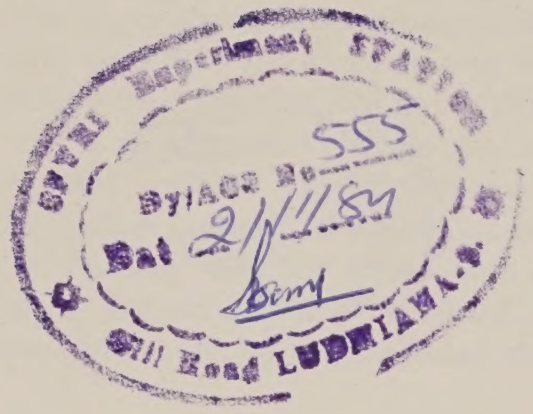

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FOREWORD

"Rural technology" is characterized essentially by its inherent capabilities of creating gainful employment, increasing productivity, recycling wastes and byproducts and producing value-added items, thereby augmenting productive work and enhancing income in a rural milieu.

Human welfare through better housing and sanitation, community services, elimination of drudgery especially among the womenfolk, promotion of decentralized techno-economic systems, particularly for the remote areas, and such other aspects of human development are also catered to by the technologies generally grouped under 'Rural Technology'.

The Council of Scientific & Industrial Research (CSIR), the country's premier scientific and industrial research organization, has done considerable work on the generation, development and demonstration of new technologies with potential for ameliorating the conditions of people living in the countryside. The Council has in the past presented them through some of its publications. While the one released as recently as October 1983 relates to "Production-oriented and Employment-generating Technologies", the present publication deals with "Technologies for Human Welfare and Community Services". These two publications are indeed a kind of 'technology shelf' for one looking for tools of development to pick and choose those appropriate to their needs.

The technologies under "Human Welfare and Community Services" do not claim to provide direct monetary benefits, but their overall gains to a family are discernible. These could be, for instance, in the form of reduction of drudgery, elimination of health hazards, and generally contributory to improved living conditions. These technologies, however, call for dissemination and diffusion of information and demonstration and training for transfer of skills. It may, perhaps, be appropriate to prepare a cadre of rural youth to take up the task of diffusion and dissemination of these technologies and provide the requisite support services. This itself could generate enough work opportunities for the unemployed rural youth.

The role of scientists in rural development is primarily to provide scientific knowledge and skills, conduct demonstration and training in the application of selected technologies and provide expert guidance and advice on the application of S & T under user/consumer conditions. The scientists would, however, keep a constant vigil on the changing needs and expectations of the people and undertake R & D tasks well in advance. I would like to emphasize here that our scientists should take

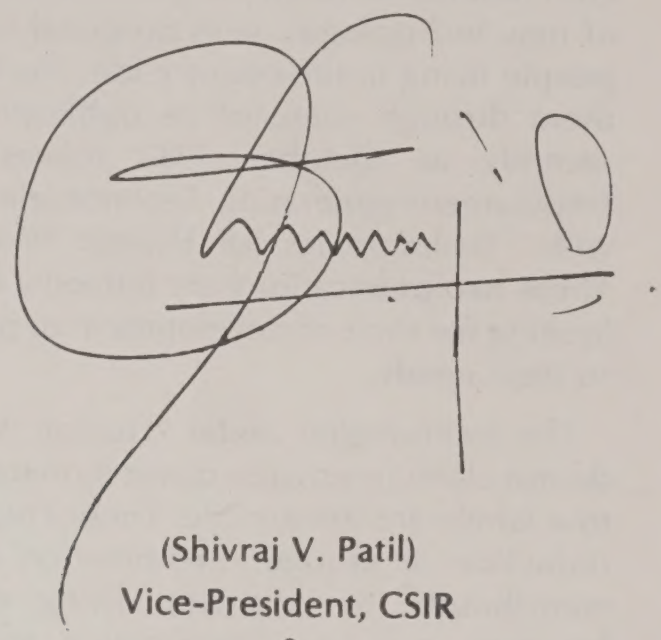
maximum advantage of the traditional/conventional practices while generating improved/new technologies for rural development because a technology representing a proper mix of the conventional and the modern would be better accepted by the people.

The actual task of demonstration, dissemination and diffusion of rural technologies has necessarily to be addressed by the state authorities like the district rural development agencies/zilla parishads, which are actually working in the rural areas. Such extension agencies have to be identified by research organizations and their constituents and proper rapport and linkages built up.

This publication is only a first step to providing information on technologies of social relevance to the masses. The rural development agencies should use the information according to their work programme and priorities. Wherever and whenever required, they could seek the help of scientists for selected demonstration and training.

Another very important endeavour of the rural development agencies should be to provide the generators of technology with feedback on the results achieved. This would not only acquaint the scientists with the problems and needs of the people, but will also help them in planning their R & D work.

This publication is a commendable attempt of CSIR and, I am sure, will meet some of the expectations of policy-makers, planners, rural development agencies, rural managers, social voluntary organizations and all those who are either directly or indirectly engaged in the task of rural development.



New Delhi
May 1984

(Shivraj V. Patil)
Vice-President, CSIR
&
Minister for Science & Technology,
Atomic Energy, Electronics, Space,
and Ocean Development
Government of India

PREFACE

Over the years, the research and development efforts of CSIR have led to a number of technologies which can be adopted in rural areas for the benefit of the people. The Vice-President of CSIR, in his foreword, has covered the role of various agencies in the application of science and technology for rural development. I would like to emphasize that those who are concerned with extension and diffusion of rural technologies must also project 'know-why' in addition to 'know-how'. This is very important in generating faith among people in the application of S&T and promoting a blend of ongoing practices with the new techniques and technologies to obtain the best results.

'Seeing is believing' and, therefore, demonstrations play an important role in extension of techniques and technologies. Audiovisuals in local languages also play a useful role in making the rural masses receptive to new as well as improvised technologies.

CSIR has built up capabilities for generating technologies and for demonstration but does not possess the adequate expertise for disseminating them on a wider scale in the field as technologies for rural development. This responsibility can best be borne by the Council for Advancement of Rural Technology (CART) and other rural development bodies like the district rural development agencies, state rural development departments, hill area development boards, tribal development departments, state councils of science & technology, voluntary organizations and rural technology institutes. Such agencies are best suited to act as a bridge between the generators of technologies and the prospective users and should also provide feedback to scientists.

As generators of technology, the CSIR laboratories are prepared to undertake selected demonstrations and training and suggest scientific methods and techniques of doing things based on scientific principles. The 'change agents' directly working in rural areas could take advantage of this service. CSIR also welcomes suggestions and proposals pertaining to the needs and expectations of rural people on areas requiring scientific investigations and research.

This publication covers a wide range of techniques and technologies for meeting the needs of a broad spectrum of users in the countryside. The information is presented in a simple language with the hope that technical details will be understood by non-specialists and field-level extension personnel.

The cost estimates given in this publication relate to the 1983-84 prices.

I must thank Dr J.C. Srivastava, Joint Adviser, Technology Utilisation Division of CSIR, for producing this useful publication and Shri P.S. Shankar of the Publications & Information Directorate for editing the manuscript.

New Delhi
May 1984

(G.S. Sidhu)
Director General
Council of Scientific & Industrial Research
&
Secretary to the
Government of India

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Abbreviations of CSIR laboratories mentioned in the publication

CBRI	:	Central Building Research Institute Roorkee 247 667
CDRI	:	Central Drug Research Institute Chattar Manzil Palace Lucknow 226 001
CEERI	:	Central Electronics Engineering Research Institute Pilani 333 031 (Rajasthan)
CFTRI	:	Central Food Technological Research Institute Mysore 570 013
CGCRI	:	Central Glass & Ceramic Research Institute P.O. Jadavpur University, Calcutta 700 032
CIMAP	:	Central Institute of Medicinal & Aromatic Plants Ram Sagar Misra Nagar Lucknow 226 016
CMERI	:	Central Mechanical Engineering Research Institute Mahatma Gandhi Avenue Durgapur 713 209
CRRI	:	Central Road Research Institute Mathura Road New Delhi 110 020
CSMCRI	:	Central Salt & Marine Chemicals Research Institute Gijubhai Badheka Marg Bhavnagar 364 002
ITRC	:	Industrial Toxicology Research Centre Mahatma Gandhi Marg Lucknow 226 001
MERADO	:	Mechanical Engineering Research and Development Organisation (many centres)
NAL		National Aeronautical Laboratory Bangalore 560 017
NBRI	:	National Botanical Research Institute Rana Pratap Marg Lucknow 226 001
NCL	:	National Chemical Laboratory Pune 411 008
NEERI	:	National Environmental Engineering Research Institute Nehru Marg, Nagpur 440 020
NGRI	:	National Geophysical Research Institute Uppal Road Hyderabad 500 007
NIO	:	National Institute of Oceanography Dona Paula 403 004 (Goa)
NPL	:	National Physical Laboratory Hillside Road New Delhi 110 012
RRL, Jammu	:	Regional Research Laboratory Canal Road Jammu-Tawi 180 001
RRL, Jorhat	:	Regional Research Laboratory Jorhat 785 006 (Assam)
SERC	:	Structural Engineering Research Centre Roorkee 247 672

AN APPROACH TO THE APPLICATION OF TECHNOLOGY FOR HUMAN WELFARE IN RURAL AREAS

India is a country of diverse social, cultural, economic, ecological and agro-climatic conditions. So are its population, languages, living conditions, and food habits. The problems, needs, expectations and aspirations of the people also differ widely from one region to another. The key to the progress of the nation as a whole is, however, the improvement of the living conditions of the rural people who form more than three-fourths of the entire population. Since most of the people are attuned to their own way of life, they meet their basic needs within the limits of their capability and capacity.

In the context of rural development, science and technology is an important tool for improving the socio-economic conditions of the people, removing drudgery among the weaker sections of society, improving sanitation and reducing health hazards, so as to achieve overall improvement in the quality of life. However, application of S & T should not be regarded as a total or an only solution to the problem of rural poverty, but as a valuable tool for complementary and supplementary efforts towards human development. In using S & T as an instrument of progress, what is of paramount importance is the choice of technology which brings about the desired change without in any way disrupting the socio-cultural traditions of the rural masses.

The policy for rural development cannot be better spelled out than enunciated in the Government of India's Technology Policy Statement (TPS) of 1983. Inherent in this is the need to inject technologies to meet the needs of the weaker sections of society in backward regions. The aims and objectives of TPS relating to technologies for rural development are to:

(1) provide the most gainful and satisfying employment to all strata of society with emphasis on the employment of women and weaker sections of society;

(2) ensure the correct mix between mass-production technology and production by the masses;

(3) identify obsolescence of technology in use and arrange for modernization of both equipment and technology;

(4) improve production speedily through greater efficiency and fuller utilization of the existing capabilities and enhance the quality of performance; and

(5) recycle waste materials and make full utilization of byproducts.

The information on 'production-oriented and employment-generating technologies' covered in the CSIR Technology Utilisation Division's earlier publication as well as the information presented in this publication, falls within the conceptual framework of TPS and can complement the ongoing efforts in rural development.

Transfer of Technology

Using S & T for the welfare of rural masses needs a different promotional and management approach. It requires blending of R & D results with demonstration, training and implementation of well-defined projects in an integrated manner. Since risk-taking capacity and entrepreneurship are minimal among the rural people, especially the weaker sections, the project formulation for promotion of such technologies should as far as possible be sieved through the following steps:

(1) identify local problems and needs and isolate priority areas requiring application of S & T;

(2) study existing levels of technologies practised and identify significant gaps, the overcoming of which may immediately attract the attention of the people;

(3) study priority areas among the ongoing programmes initiated by rural development agencies and identify technological gaps, if any;

(4) harness matching techniques/technologies to bridge the above gaps and study the scope of working out a mix of both traditional and new techniques;

(5) prepare an integrated project proposal for community and/or individual family use aimed at (i) direct application of known knowledge, (ii) modification of a known technology to make it adaptable to the local situation, (iii) upgradation and rationalization of traditional skills, and (iv) development of new techniques as required;

(6) interact with local leaders, target groups, development staff, voluntary agencies, etc. for finalizing the programme;

(7) ensure supply of inputs for implementation of improved/new technology;

(8) involve the target groups/beneficiaries to participate actively in demonstration/training programmes;

(9) arrange training of key personnel and trainers to facilitate dissemination, diffusion and replication of the technology;

(10) monitor the project in the initial stages of implementation, help in the solution of any teething troubles, and provide expert counselling to eliminate risks of failure; and

(11) provide regular feedback to the generators of technology.

Promotional Approach

The first step in the promotion of technologies listed in this publication should be direct demonstration within the earmarked ongoing rural development projects of the District Rural Development Agencies (DRDA). In mass and community adoption projects, it would be advisable to organize campaigns to explain the know-how and know-why of the projects in advance. Local teachers and students should be involved in this task. Some projects (e.g. rodent control based on CSIR technology) may require a whole village or even the involvement of a cluster of villages. Here, the dynamics of human behaviour and the advantages of resources and management services will have to be fully exploited. Local people will have to be educated, inspired and induced to give a trial to the technologies being offered through discussions, visuals, demonstra-

tions, training or even single-point delivery with post-delivery maintenance services, etc.

Women are the main architects of change in rural areas. They should invariably be involved to function as motivators. To begin with, it may perhaps be advisable to select an area where the basic conditions of life are relatively homogeneous; it is also necessary that the size of the project is such that it is easily managed by the available extension staff. While these technologies provide an idea of the scope of their application in rural areas, some of these may require necessary adaptation or a different promotional approach to suit a particular situation.

Investment Decision

At present, technologies pertaining to human welfare are generally available at zero cost. Any improved or new technology, however, demands some investment. Even if there is a conceived advantage, a rural person will weigh it along with his own practices in terms of priorities of investment in income-augmenting activities. He will also weigh the expected benefits over those of traditional practices, whether they relate to adoption of an improved *chulah* (cooking stove), or a soakage pit, or a latrine, or a shelter. The advantages of these techniques and technologies will, therefore, need explanation in terms of appropriate direct/indirect socio-economic benefits and impact on rural families or the village community as a whole.

While a number of projects need community participation and responsibility, others need public funding, incentives or motivation of one kind or another.

Support Services and Action Research

Diffusion of technologies for human welfare and community services would require an integrated approach and continuous educational programme supported by needed inputs within means and easy reach of the target groups/beneficiaries. This may need promotion of support services in the form of contract or trusteeship, institutional framework, franchise network or the concept of 'repairwalas' on the pattern of organized industrial sales promotion. Convincing local leaders and change agents taking the lead in adopting such technologies may perhaps complement the extension efforts.

Scientists of the Council of Scientific & Industrial Research have been conducting researches and working on the adoption of appropriate technologies in rural areas for human welfare and community services. They have also been conducting field trials in nearby villages to test the results of their researches under the actual rural environment. Such field action not only generates confidence in their own competence, but also exposes them to the physical conditions obtaining in the rural areas. Many of the experiences arising out of these field trials have provided vital feedback to the laboratories, which in turn take up future projects which are likely to have a greater socio-economic impact in times to come.

The CSIR scientists have tried to set up certain models to show how a technique/technology could be effectively transferred to rural areas. If these efforts of scientists are complemented and supplemented by extension agencies and government departments concerned with rural

development, their initiative can help people to help themselves in improving their life situations.

The techniques and technologies for human welfare and community services available from CSIR laboratories are presented here in the form of a 'Technology Shelf' so that people could pick and choose in relation to their own needs.

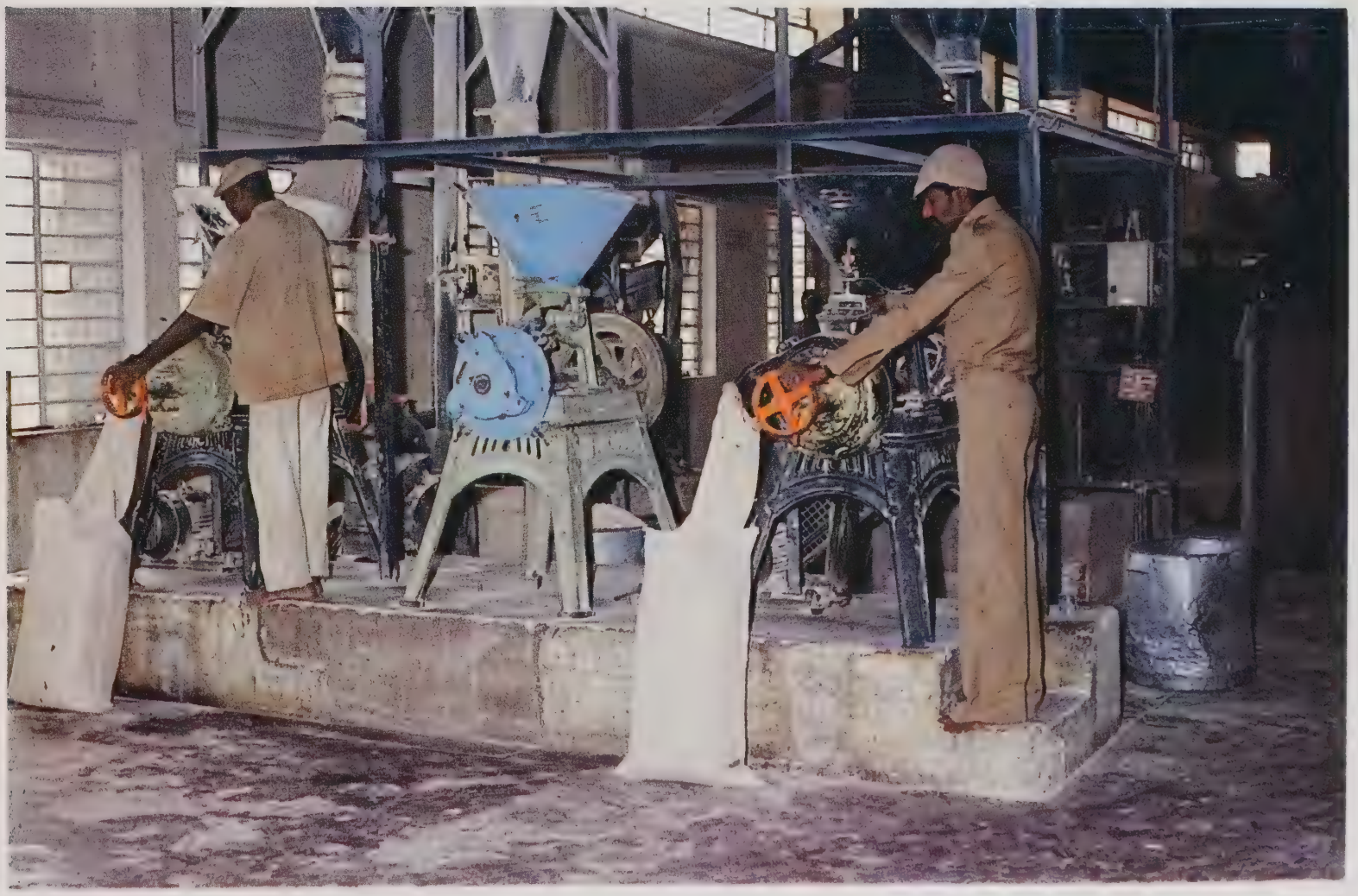
The technologies presented here are broadly grouped under eight major sections: Food; Water; Health & Family Welfare; Sanitation & Environment; Human Settlement ; Roads & Communication; Energy; and Natural Resources. It is however to be clarified that the grouping is not water-tight as any technology has more than one objective. Although the sectional headings do not follow in alphabetical order, but conform to some perceived priority, the technology titles under each sectional head are given in alphabetical sequence.

As these technologies are available at different stages of development, their adoption in some cases may perhaps need locational trial and 'action research'. The role of CSIR is confined generally to providing information and to conducting a limited number of selected demonstrations and training programmes.

Additional information on these techniques and technologies could be obtained by contacting either the respective CSIR laboratory or the Technology Utilisation Division, CSIR, Rafi Marg, New Delhi 110001.

FOOD

COMMERCIAL PRODUCTION OF BAL-AHAR



Food

While the green revolution has transformed the food scene, there is enormous scope for further augmenting the food grain resources. The lack of appreciation for utilization of appropriate post-harvest technologies, for better utilization of byproducts and wastes, and for prevention of food losses at the rural level, if allowed to grow, could eventually offset the gains of the green revolution. Some of the CSIR laboratories, CFTRI in particular, have therefore concentrated on the development of such technologies as are amenable for adoption by cottage and small-scale industries around the places of production. The advantage of such technologies is avoidance of transportation of materials to urban areas and consequent energy savings. More important, the rural community gains in terms of value-added products, more work opportunity and income.

Since improper storage conditions under high humidity account for heavy food losses, it is very important to adopt improved storage practices. Thanks to CFTRI's work, different techniques and technologies with the scope of adoption in varying locational needs and situations are available. Improvement in the processing of many food grains has helped increase the yield of food from the grains as harvested.

With regard to plantation produce like tea, coffee, spices, etc. the CSIR's researches have resulted in diversification into non-traditional products that have added value and are creating new and wider markets.

Malnutrition, another debilitating feature especially of the rural community, has received attention by CFTRI. To overcome the protein calorie malnutrition in young children, CFTRI has come out with nutritious foods. It has harnessed, for instance, oilseed cakes (used as cattle feed) production of inexpensive protein-rich foods. A number of alternative food supplements which are within the means and reach of rural people have also been offered. To popularize the use of such nutritious food supplements, attention has also been paid to educating the rural masses on the need and value of sound nutrition and health.

1

BAL-AHAR (BABY-FOOD)
(CFTRI, Mysore)

Bal-ahar is a food product which the Central Food Technological Research Institute (CFTRI), Mysore, has developed for use by children of age group 6-11 years and also for pre-school group. It is to be used as gruel by boiling in hot water and adding sugar or salt to taste. It provides 360 cal. and 22 g protein per 100 g.

This food is used primarily in programmes of feeding school children and other similar nutrition programmes. The process consists in grinding cleaned raw materials to flours and fortifying with necessary vitamins and minerals. The blend consists of 65 parts of wheat flour, 25 parts of groundnut flour, and 10 parts of Bengal gram flour.

A unit processing 300 tonnes a year will involve a capital outlay of about Rs 8 lakh and can produce Bal-ahar at Rs 6/ kg.

Bal-ahar has been approved by the Food and Nutrition Board for distribution under the special Nutrition Programme for School Children.

Some 40,000 tonnes of Bal-ahar are being produced annually by the Food Corporation of India.

2

BLEACHING IN-SHELL WALNUTS
(RRL, Jammu)

India ranks fifth among the walnut *(Juglana regia)* producing countries in the world. Quality requirements for export demand a well-bleached, clean product with an attractive and bright shell appearance. Even in the home market such a product naturally fetches a better price.

The traditional practice of bleaching involves raking of walnuts (in lots of 40-50 kg) in solutions of soda ash/quick lime/bleaching powder/mild caustic, singly or sometimes in combination. After this initial treatment, the walnuts are transferred to a tank containing dilute sulphuric acid. From this tank they are transferred to clean water for rinsing and washing and finally sun-dried for 2 days.

This process is ineffective, crude and cumbersome. During the treatment some water enters the shell through crevices, making the kernels prone to fungus attack.

The Regional Research Laboratory (RRL), Jammu, has developed an improved technology for bleaching walnuts. The process involves treatment of nuts with the solution in a mechanically tilted enclosure which effects surface abrasion due to fast agitation. During a short reaction time of 3-5 min., the adhering resinous material is loosened and separated from the shell and simultaneous surface bleaching takes place as a result of chemical action. The nuts are rinsed in plain water for a minute and sun-dried.

While the improved technology has already been adopted, efforts are being made by the RRL to further improve the device and also to introduce complete mechanization so that the entire bleaching operation takes place in a single composite unit.

3

CASHEWNUT DECORTICATOR

[MERADO (CMERI), Cochin]

Manual shelling of cashewnuts with the use of wooden mallets, steel rods, etc. is followed in most of the processing plants in India. A great disadvantage here is that workers are forced to sit on the floor and perform the shelling for long hours, leading to human fatigue and drudgery. The workers are additionally exposed to health hazards due to contact with the corrosive shell liquid. The productivity in such cases is usually 6-8 kg per worker. A few hand-cum-foot-operated shellers of crude design are in use in a few places in Karnataka.

A refined and reliable machine, which can be conveniently mounted over a work table, has been developed by the Mechanical Engineering Research and Development Organisation (MERADO), Cochin. It is similar to a foot-operated sewing machine, which can be operated by a worker sitting in front of it. The decorticator improves productivity without causing labour-displacement problems. The machine is run manually.

The decorticator including the mounting arrangement costs about Rs 350.

Cashewnut decorticator

Manufactured on the basis of the MERADO's design, the decorticator is available from: Carbide Tools (India), Carbide House, Ayyanthole, Trichur 4.

4

CURING NEW RICE
(CFTRI, Mysore)

The rice obtained from freshly harvested paddy cooks to a pasty mass, swells less and loses more of solids into the gruel (*kanjee*). Storing rice for 6-10 months improves its cooking characteristics, but such rice is more expensive because of storage costs.

A process developed by the Central Food Technological Research Institute (CFTRI), Mysore, for quick artificial curing of new rice overcomes the drawback as it develops the desirable cooking properties of old rice. The process of curing consists in steaming paddy for a short time in steaming tanks and keeping it hot for 2 hr followed by drying in shade. The process improves the cooking quality, and yields stable lipase-free bran. The cured rice contains more of thiamin and has better storage quality also.

Many rice mills in Mysore district are using this technology, and steamed rice is presently marketed commercially.

5

EDIBLE GROUNDNUT FLOUR
(CFTRI, Mysore)

Edible groundnut flour a product of the Central Food Technological Research Institute's researches—contains about 50% protein and good quantities of calcium and phosphorus. Prepared under hygienic conditions to edible standards, the groundnut flour can be used to raise the protein content of traditional food preparations and to fortify *atta* (flour). Incorporation of this flour even at 5% level would increase the protein content of *atta* by 2.5% without much of extra cost. Since India is a leading producer of groundnut, the technique developed at CFTRI can be advantageously used by the oil mills to produce edible-quality groundnut cake with a slight modification of the existing method.

Edible groundnut flour is currently being used in India in the manufacture of a variety of protein-rich foods such as Bal-ahar, Indian Multipurpose Food, protein-enriched biscuits, energy food, and extruded snack foods. Edible-quality groundnut cake can fetch a higher price than the ordinary commercial cake.

The edible groundnut flour is being manufactured by three firms: (1) The Adoni Fertilizers Manufacturers, Kurnool Dist., (2) Sri Rangavilas Ginning and Oil Mills, Coimbatore; and (3) T.G. Lakshmiah Shetty & Sons, Adoni, A.P.

6

ENERGY FOOD
(CFTRI, Mysore)

Energy foods are a class of calorie-rich nutritive food supplements based on blends of indigenously available raw materials such as wheat, maize, Bengal gram, edible-quality groundnut flour, and jaggery, fortified with vitamins and minerals. Such foods are mainly intended for meeting the demands of social welfare programmes and nutrition programmes.

A typical energy food formulated by the Central Food Technological Research Institute (CFTRI), Mysore, consists of 60 parts of cereals (wheat, maize), 10 parts of Bengal-gram flour, 10 parts of edible groundnut flour, 30 parts of jaggery, and 1 part each of calcium carbonate and vitamin premix. The product may be consumed as such or by mixing in water or milk as porridge/balls. It provides 390 cal. and 16 g protein per 100 g.

Four units for the manufacture of energy food have been set up in Karnataka by the Karnataka State Agro Corn Products Ltd, Bangalore. So far, more than 22,000 tonnes of the energy food have been produced, the beneficiaries being primary school children, numbering about 200 million.

In a small-scale production unit capable of producing daily 3 tonnes of energy food, involving a capital outlay or Rs 12 lakh, the production cost would be about Rs 4.50/kg.

School children relishing 'Energy Food'

7

FERROCEMENT STORAGE BINS (CYLINDRICAL) FOR FOOD GRAINS

(SERC, Roorkee)

The ferrocement bins developed at the Structural Engineering Research Centre (SERC), Roorkee, are cylindrical in shape and are assembled from prefabricated components, viz. base slab, wall unit, and dome-shaped roof unit. Bins of 1-,2- or 3-tonne capacity may be assembled by erecting one, two or three wall units, one over the other, and filling up the joints. A manhole is provided in the roof unit for loading and an outlet is provided in the bottom wall unit for unloading the grain. Gaskets are provided for the inlet and outlet to make the bins air-tight. Locking arrangements are also provided. The external surface of bins is painted with a bituminous aluminium paint. The sizes of the various components of the bins are such that the units can be handled and erected by four persons. The wall units are cast by using the semi-mechanized process, also developed at SERC.

Ferrocement is a highly versatile form of reinforced mortar consisting of closely spaced layers of wiremesh reinforcement impregnated with a rich cement mortar. It is possible to cast ferrocement elements with a thickness of as small as 1 cm with 2 to 3 mm cover on either side. Ferrocement possesses high resistance to cracking, and unlike steel structures, has high corrosion resistance.

Ferrocement bins have the following advantages:

- Cheaper than steel, reinforced concrete, and aluminium bins.
- Lighter than conventional reinforced concrete bins.
- Require little or no maintenance.
- The condensation and moisture migration problems in food grains stored in ferrocement bins are much less than in food grains stored in steel bins.
- Rodent-proof, fire-proof and damp-proof, the ferrocement bins can be made air-tight easily by sealing the inlet and outlet openings, and hence the bins retain fumigants well.
- Any structural damage can be easily repaired.
- Can be easily fabricated at the rural level.

The fabrication technology is simple and can be easily acquired by the rural artisans.

A large number of demonstrations and trials have been conducted, over the period 1975-81, on casting, assembling and testing processes at various places:

CFTRI, Mysore — 1975

NOIDA village, Jhundpura village exhibition, Dist. Ghaziabad (U.P.)—1978

Wardha (Maharashtra) 'Science for Villages' exhibition—1978

Karimnagar (A.P.)—1977

India International Trade Fair, New Delhi—1978

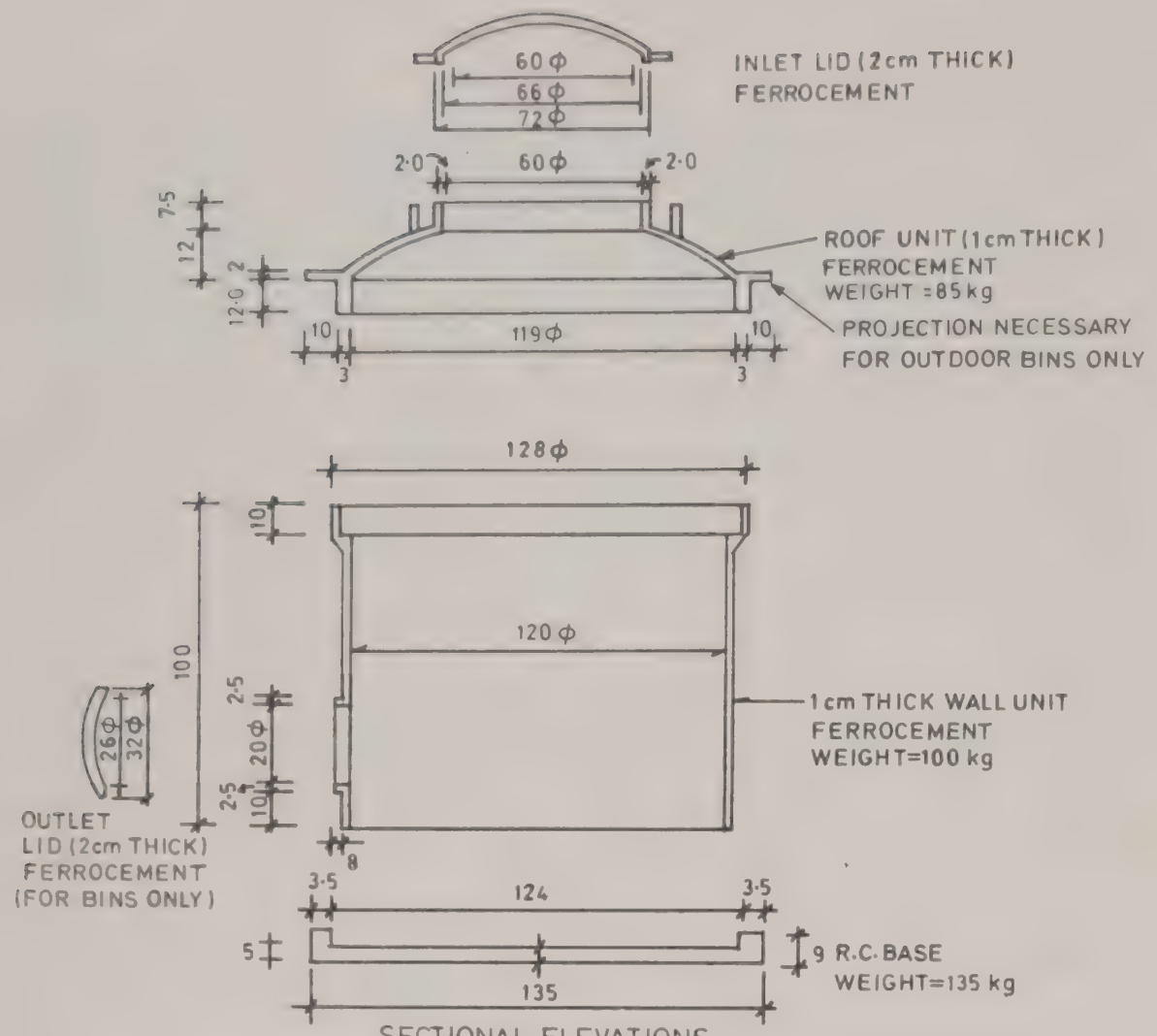
National Trade Fair, New Delhi—1979

Agriculture Exhibition, Madgaon, Goa—1980

Village Singhavli, Dist. Meerut (U.P.)—1980

Agriculture Fair, Punjab Agricultural University, Ludhiana—1981

Villages around Ludhiana in collaboration with PAU, Ludhiana—1981



Drawings for prefabricated ferrocement units for storing food grains

Training

A large number of entrepreneurs have been trained in the semi-mechanized process of producing ferrocement cylindrical units, the entrepreneurs representing the following firms: (1) Uttarakhand Concrete Products, NOIDA, U.P.; (2) St Pedro Precast Unit, Panaji, Goa; (3) Indian Concrete Products, Meerut, U.P; (4) Building Construction & Repair Corporation, Ghaziabad, U.P.; (5) Sukhnidhan Engg Co., Village Rampur, Channa Dist, Sangroor; and (6) Ashok & Associates, Lucknow, U.P.

Adoption of Technology

Out of 16 entrepreneurs who were given the technology 12 are in production. The ferrocement water tanks are now available in the market. These have been accepted for use by a number of organizations like U.P. Jal Nigam, U.P. Public Works Department, Central Public Works Department, Military Engineer Services, Uttar Pradesh Small Industries Development Undertaking, Avas Vikas, on large scale.

All the necessary raw materials are available in the open market. The process equipment can be fabricated with the detailed drawings provided by SERC. Items of equipment are easily available in local markets.

8

FILTER PAD TO REMOVE AFLATOXIN

(CFTRI, Mysore)

More than 80% of the groundnut oil produced in the country contains aflatoxin at levels higher than the permissible limits of 0.03 mg/kg, posing a serious public health problem. Aflatoxin is a potent carcinogen, produced in groundnut kernels infected with the fungus *Aspergillus flavus*. The toxin is carried over to groundnut oil when infected groundnut kernels are processed for oil.

To get round the aflatoxin contamination, the Central Food Technological Research Institute (CFTRI), Mysore, has developed a special filter pad which can be used in place of the filter cloth normally used in oil mills for the production of groundnut oil. The special filter pad is designed to remove both suspended and dissolved particles of the toxin to the extent of 90%.

This treatment costs an extra 1-2 paise per kg of the filtered oil. The process of making and using filter pads has been given over to five oil millers for their own use.

It is estimated that a unit with a capacity to produce 250 filter pads daily can produce them at Rs 19 a piece. The filter pad can be used 3-4 times after revivification.

9

FOOD — PACKAGING

(CFTRI, Mysore)

Packaging is vital for protecting and maintaining the quality of food right from the point of production to the market and beyond. Development of food packages and packing to meet the specific functional needs of different kinds of food products is one of the important R&D activities of the Central Food Technological Research Institute (CFTRI), Mysore.

Packaging for Fruits

Conventional baskets made from bamboo splits or *arhar* (pulse) twigs that are widely used for transporting fruits and vegetables suffer from structural defects, instability, poor stacking strength, and deformity during transportation. Improved baskets have been designed with these materials and successfully used for transportation of different kinds of fruit like mangoes, grapes, apples, and pineapples.

Packaging for Bananas

Designs of wooden and corrugated fibreboard boxes have been evolved for use in domestic and export trade of bananas and oranges.

Telescopic boxes are currently used for packing export consignments of bananas. A five-panel, stacked and collapsible corrugated fibreboard box, which uses 30% less packaging materials than the conventional boxes and which also eliminates the stapling operation at the packing centre, has been designed for export of bananas.

Pre-packaging

A technique of pre-packaging fresh fruits and vegetables in consumer packs has been standardized. This reduces injury and weight losses in

A sample fish basket

the produce during distribution, and also extends its shelf-life and ensures hygienic distribution.

Fish Container

An improved, reusable, fish container has been developed to help small-scale operators transport iced fish without spoilage, to distances of more than 350 km, and hence reach a wider consuming area.

Egg Container

An egg container with improved cushioning effect has been designed to reduce breakage and maintain quality of eggs during transportation.

Cartons for Oranges

For export and long-distance transportation of oranges and other fruits grown in the country, CFTRI has developed a fungicidal wax formulation which helps maintain their freshness and minimize spoilage during transportation. Also, suitable wooden packing cases and corrugated fibreboard cartons have been designed for long-distance transportation to reduce damage to the commodity.

10

FRUIT-PACKING CASES FROM PINE NEEDLES

(RRL, Jammu)

Mountainous regions in India, particularly the Himalayas, have vast areas covered with pine forests. Enormous amounts of dry, brown pine needles falling from the trees cover the ground in thick layers. These needles pose a serious fire hazard in the forests. The needles covering

the ground also prevent the growth of new trees and grasses. As a solution to this environmental hazard, the Regional Research Laboratory (RRL), Jammu, has evolved a technology for making pine-needle boards which could be used for making boxes for packing fruits. The boxes made from pine-needle boards would also contribute to reducing the need for timber use, thus in turn contributing to the conservation of forests.

The first plant for the manufacture of pine-needle boards and boxes based on the RRL technology is being set up by the Himachal Pradesh State Forest Corporation at its subsidiary at Bilaspur. RRL is providing a complete turn-key job. Such a unit, when it starts production, would generate full employment to more than 50 people in the factory and part-time employment to about 100 people engaged in collection, bailing and transporting the needles from the forests to the factory site. As most of the temperate fruit orchards are located near these forests, the manufactured product could be consumed in the same area.

Fibre boards also find a number of other applications like panelling material for ceilings, partition walls, shop fittings, radio/TV cabinets, etc.

FUMIGATION (MINIFUME) FOR FOOD GRAINS AND SEED STORAGE

(CFTRI, Mysore)

Grains and pulses during storage are prone to insect infestation and consequent damage, resulting in nutritional as well as economic losses to the consumer and trade. A simple, easy and safe method of disinfesting insect-infested food grains and pulses is now available as a result of the work of the Central Food Technological Research Institute (CFTRI), Mysore.

In this method, known as Minifume technique, a glass ampoule containing the fumigant is wrapped in an absorbent material like filter paper, and re-wrapped in a strip of corrugated cardboard, which is then stapled together at the two ends. When such a package is dropped from a considerate height, the ampoule inside it does not break. However, it can be broken by a sharp tap on the outside of the package. The fumigant inside the ampoule would then be absorbed in the filter paper (or any other absorbent material) and slowly released through the cardboard package. Such a package can be successfully used for the mini-fumigation of small stocks of food grains and seeds in rural and urban households.

A limited quantity of Minifume tablets was produced in the pilot plant at CFTRI and sold through the CFTRI Consumers' Cooperative Society at Re 1 a tablet. The know-how has not been released to any party. However, it is presently manufactured and distributed as EDB ampoules under the Save Grain Campaign of the Government of India.

12

GROUNDNUT DIGGER
[MERADO (CMERI) Ludhiana]

A bullock-drawn groundnut digger has been developed by the Mechanical Engineering Research and Development Organisation (MERADO), Ludhiana. It has a working width of 50 cm and is suitable for both erect and semi-erect types of groundnut varieties. The digger has a field capacity to dig 0.125 ha/hr.

Field trials were conducted during groundnut harvesting season in small areas near Ludhiana (Punjab). The cost of the machine has been estimated at Rs 1600. The technology has yet to be released for manufacture.

13

MALTED BEVERAGE
(CFTRI, Mysore)

The process for malted beverage developed by the Central Food Technological Research Institute (CFTRI), Mysore, employs either a protein isolate or a protein-rich flour of edible quality as the base.

The process consists of the following stages: The protein isolate or protein-rich flour is mixed with fine flour of malted millet, sugar, cocoa, etc. The water content is adjusted to give the required dispersion and the mixture is dried either in a vacuum shelf-drier or in a spray drier. The dried product is cooled, ground to a desired particle size, and packed in suitable containers.

This product is now produced commercially and is considered cheaper than similar products based on milk and milk powder. The process has been commercialized by five organizations: (1) Mysore Food and Farm Products Pvt. Ltd, Bangalore; (2) Cocoa Products and Beverages (P) Ltd, Madras; (3) Sterling Malt Foods (P) Ltd, Gwalior; (4) S.P.S.S. Industries, Tiruchirapalli; and (5) Andhra Pradesh Dairy Development Corporation Ltd, Hyderabad.

The malted beverage was developed as a food based on vegetable protein sources indigenously available. Being a source of protein other than milk, the beverage could help make available milk for those who need it most.

14

MALTED WEANING FOOD
(CFTRI, Mysore)

Growing infants require a soft semi-solid food supplement in addition to mother's milk. Thus, food supplements or weaning foods are commercially made by the extrusion or the roller-drying process. However, they are expensive and beyond the reach of the target group who need the product. The Central Food Technological Research Institute (CFTRI), Mysore, therefore, studied the ways and means of developing less costly, but equally nutritious, weaning foods which are within the means of wider population groups. The raw materials studied are locally available staple grains. A typical weaning food mix comprises 70% cereal and 30% legume. The cereal used is ragi *Eleusine coracana*

Mother feeding child with a weaning food

and the legume base is greengram. *Ragi* can be substituted with malted *bajra* or malted *jowar* or wheat.

The two components are steeped in water, germinated and dried. The vegetative portion is removed by a gentle abrasion, greengram dal is ground in a *chakki* (mill), directly, whereas malted *ragi* is slightly moistened and immediately ground in a *chakki*,and sieved to remove bran. The malted flours are mixed in the ratio of two parts of cereal flour to one part of legume flour. This is the basic blend, which can be fortified with iron, essential vitamins, and skim milk powder.

The nutritive value of this weaning food has been tested; it has a protein efficiency ratio of 2.4. Feeding trials with children have shown that the food is well tolerated and accepted.

The weaning food is being manufactured by (i) Titan Protein Food Formulations, Mysore; (ii) Greenfield Drugs & Chemicals Ltd, Industrial Estate, Yadavagiri, Mysore; and (iii) Kaira District Cooperative Milk Producers' Union, Anand. It is being produced commercially under the brand name Weanex.

15

MILTONE
(CFTRI, Mysore)

Miltone is a pasteurized or sterilized milk-like product possessing nearly the same characteristics as natural milk. In this product — the result of technology developed by the Central Food Technological

Research Institute — groundnut protein isolate is used for toning animal milk in place of the conventionally used skim milk powder, thus extending the availability of milk.

In this process, the wet protein obtained from edible groundnut flour is reconstituted in water and mixed with sugar, salts and vitamins. The vegetable milk base is mixed with animal milk in the desired proportion, homogenized, pasteurized, and bottled. The product can also be flavoured, bottled and sterilized. Sterilized Miltone has a longer shelf-life of 3-4 months. The raw materials used are cow/buffalo milk, edible groundnut flour, sugar, minerals, and vitamins.

Miltone is being manufactured by the Bangalore Dairy, Ernakulam Dairy and Hyderabad Dairy under the Food and Nutrition Board of the Government of India. Miltone costs about 15% less than milk.

16

MULTIPURPOSE FOOD
(CFTRI, Mysore)

Multipurpose food (MPF)—a product of research by the Central Food Technological Research Institute (CFTRI), Mysore — is primarily intended to supplement the diet of children and expectant and nursing mothers, but can be used by others also. Daily supplementation of the diet with 55-60 g of MPF significantly improves the nutritional status of

Fig.7 Effect of feeding the protein-rich Multipurpose Food on a child for about 40 days: the improvement of the child (right) is perceptible.

the consumer. Feeding trials have shown that MPF is highly effective in the treatment of a protein-deficiency disease called kwashiorkar.

The MPF developed at CFTRI is a blend of 75 parts of edible groundnut flour and 25 parts of roasted Bengal-gram flour and is fortified with vitamins and minerals. A spice mixture is added for seasoning MPF.

Greenfield Drugs and Chemicals Pvt. Ltd, Mysore, is producing MPF on a commercial basis. The product is sold under the name Nutroprotein at Rs 9/kg.

17

NUTRO BISCUITS
(CFTRI, Mysore)

Bakery products such as bread, buns, biscuits, and rusk are becoming more and more popular even among the middle and lower-middle classes, and hence the growing demand for them. Also coming into increasing use are foods fortified with vitamins and nutrients. Such foods are useful as supplements to the diet of children, invalids, convalescents and such other nutritionally vulnerable groups.

To meet the increasing demands for such food articles, the Central Food Technological Research Institute (CFTRI), Mysore, has developed a special kind of biscuits: nutro biscuits. They are sweet biscuits, fortified with calcium and vitamins, and contain 15-16% protein as against 5-6% present in ordinary biscuits. For protein enrichment, specially prepared groundnut flour is used to the extent of 40% of wheat flour.

Large quantities of nutro biscuits have been distributed by the Indian Red Cross Society and the Meals for Millions Association of India to a number of hospitals, schools and welfare centres, primarily for the benefit of children. Protein-rich biscuits were taken up for commercial production by Unichem Products (Lab), Bombay, and Britannia Industries Ltd during the sixties. Presently, A.C Gangaram and Company, Mysore, is producing such biscuits in the country.

18

PADDY PARBOILING
(CFTRI, Mysore)

Nearly 50% of the total paddy produced in the country is parboiled by the traditional method. Parboiling reduces breakage during milling and gives a higher yield of marketable head rice with good retention of nutrients. The parboiled rice produced by traditional methods is not liked by many rice-eaters because of its fermented smell and undesirable colour, as well as the stiff consistency of the cooked grains.

As a solution to this problem, the Central Food Technological Research Institute (CFTRI), Mysore, has developed an improved hot soaking process which yields rice free from undesirable characteristics of the traditional parboiled rice with considerable reduction in processing time. The processing system consists of a mild-steel tank

fitted with steaming coils both for heating the water and steaming paddy. The standard units have tanks designed to process 3-4 tonnes of paddy per batch with provision to keep it at 70°C during the soaking period. Tanks of varying capacities can be fabricated and used depending on the requirements. The process consists in soaking cleaned paddy in hot water tanks for 3-4 hr, draining the soak water, steaming the paddy until the husk starts splitting, and drying it either in the sun or by using a mechanical drier. Dried paddy is then milled to obtain parboiled rice. Parboiling costs just 4 paise for a kilogram of paddy.

CFTRI has supplied designs to 17 parties. The technology has been adopted by two parties: Haryana Steel Fabricators [No. 1, Industrial Area, Dabwali Road, Sirsa (Haryana) 125 055]; and Shri Chalhan Vibhag Khand Udyog Sahakari Mandi Ltd (P.O. Chalthan 394135, Surat District).

19

PAUSHTIK ATTA

(CFTRI, Mysore)

To improve the nutritive value of wheat flour as also to relieve pressure on wheat, the Central Food Technological Research Institute (CFTRI), Mysore, has offered a novel product—*Paushtik atta*. It is very simple to produce and does not need intricate or expensive equipment. *Paushtik atta* consists of a blend of 75 parts of whole wheat flour, 17 parts of tapioca flour, and 8 parts of specially prepared low-fat edible groundnut flour. It can be used for preparing *chapathis* and *puris* as with *atta* (flour).

Trials carried out at different centres in the country have shown conclusively that the product is generally acceptable to wheat-eaters.

The process can be adopted by any local flour millers.

20

RICE FLAKES—IMPROVED TECHNOLOGY

(CFTRI, Mysore)

Flaked rice *(poha)* is an extensively used traditional food, the flaking of rice being a widely distributed cottage-scale industry in India.

The traditional method of making rice flakes consists in sand-roasting of soaked paddy followed by flaking. This results in low yields, excessive breakage during the final stages of flaking, and contamination with husk particles in the flaked rice.

To overcome these defects, the Central Food Technological Research Institute (CFTRI), Mysore, has standardized an improved batch-wise as well as continuous process of making rice flakes. The improved process consists in soaking the paddy in hot water, roasting the soaked paddy, shelling, polishing, and finally flaking in a flaker. This process increases the yield with minimum breakage in flaked rice.

Optimal processing conditions of operation have been standardized. Equipment suitable for producing rice flakes are being streamlined. A prototype flaker is being fabricated.

The technology has been demonstrated to some parties interested in modernizing the existing facilities.

21

RICE HARVESTER
(CMERI, Durgapur)

Keeping in view the shortage of labour during peak harvesting and the need for timely preparation for the next crop, the Central Mechnical Engineering Research Institute (CMERI), Durgapur, has developed a self-propelled, small harvesting machine suitable for paddy, wheat and other food grains. The main harvesting unit works on the rotary cutter principle. With the harvester moving forward, the blade cuts the crop, which is collected in a small plate that ejects the crop at intervals. With accessories, it can be used as a power tiller for puddling, ploughing and transporting the crop. It has a capacity for harvesting 1.2-1.6 ha a day (8-10 man-hours); it is driven by a 5 hp diesel engine.

The machine can be used by small-holding farmers. It costs Rs 15,000 (without accessories). The design has been given to Super Machine Tools Pvt. Ltd, Calcutta, who are fabricating and selling the harvester.

22

RODENT CONTROL
(CFTRI, Mysore)

A rodent control technique, which is an improvement over, and integration of, conventional techniques, has been standardized by the Central Food Technological Research Institute (CFTRI), Mysore.

Rodent control by poison-baiting and trapping in a field

This technique involves the poison-baiting of rats with a suitable rodenticide, a bait formulation, and bait stations; fumigation of rat burrows by the use of a simple fumigant formulation, which is safe and easy to apply; driving the rats away from sources of food; and attracting them towards the bait. The technique has a higher rate of success. All are simple equipment and are locally available everywhere.

A servicing unit envisaged as a self-employment scheme will involve an investment of Rs 3,000. The cost estimate for successful rat control in a village of 100 households would be Rs 500, and the expected income Rs 800.

The technique has been demonstrated in several situations and rural areas, and is presently adopted by many pest-control agencies and operators.

23

SIMPLE WHEAT-MILLING TECHNIQUE

(CFTRI, Mysore)

Presently, about 80% of the total wheat grown yearly (36 million tonnes) is ground in about 3 lakh units of *chakkis* (disc mills), operating in cities and electrified villages. The milled product, *atta* (whole wheat flour), is mainly used for preparing *chapathi* or *roti*. *Maida* (refined wheat flour), on the other hand, is processed in highly capital-intensive and sophisticated roller flour mills. *Maida* is the main raw material for bakery industry, the annual turnover of which is worth more than Rs 2500 million. Nearly half of bakery products are manufactured by small and cottage-scale units. Small scale sector units are often confronted with problems of obtaining ready supplies of *maida* of desired quality and quantity. Consequently, bakers cannot produce baked products of uniform and desired quality.

It is against this background that the Central Food Technological Research Institute (CFTRI), Mysore, took up the development of a simple wheat-milling technique for simultaneously obtaining bakery flour and *atta* for making *chapathi/roti*. Such a milling process can be of great relevance to rural areas, more so in the light of the government's policy, announced recently to encourage the growth of bakery industry in the small-scale sector.

The process consists in cleaning wheat, conditioning it, removing bran by polishing, grinding, and sieving. In the sieving process, both the fractions — whole wheat *atta* and bakery flour — are obtained.

The equipment required are a hand-operated mixing drum, a huller, two *chakkis*, and a sieving unit, all of them being available throughout the country.

The total investment for a unit handling 8 quintals of wheat in a day (8 hr) is about Rs 50,000.

Other special features of this technique are: low capital investment; potential for self-employment; no need for skilled personnel; utilization of 95% of the grain with negligible nutrient loss; feasibility of working the process on service-charge basis; and adaptability for *sooji*-milling of *durum* wheats.

This process has been demonstrated to 12 parties.

Wheat-milling machine

24

SMALL RICE-POLISHING MACHINE

(CMERI, Durgapur)

A small, compact rice-polishing machine has been developed by the Central Mechanical Engineering Research Institute (CMERI), Durgapur, working in partnership with the Indian Institute of Technology, Kharagpur. The machine can polish 200-300 kg of raw or parboiled rice in an hour. The machine has many advantage. It requires very little space, and less driving power than conventional machines. The grain pressure inside the machine being less, the breakage loss is reduced. It requires less initial and running expenditures and is suitable for small rice millers and farmers.

The unit costs about Rs 2500 without the prime mover

The rice polisher was developed under a project sponsored by the Union Minister of Agriculture

25

TAPIOCA MACARONI
(CFTRI, Mysore)

A supplementary food of high nutritive value, tapioca macaroni takes very little time to cook. It is richer in calcium, phosphorus and proteins than rice. The Central Food Technological Research Institute (CFTRI), Mysore, has developed a process for tapioca macaroni. It is a blend of 60 parts of tapioca flour, 25 parts of wheat semolina and 15 parts of low-fat edible groundnut flour. The macaroni can be made in the shape of rice, tubes, shells, alphabets, etc. by using appropriate dies and adjusting the cutter in the extrusion press.

Nutritional feeding trials have shown that tapioca macaroni can replace rice in the diet without affecting its overall nutritive value. The institute has demonstrated that its large-scale use can stretch the availability of food grains, especially in times of scarcity.

The tapioca macaroni compares favourably with rice in price, the additional advantage being that it saves on energy needed for cooking. The production and use have been widely demonstrated in several parts of the country.

26

VINEGAR PRODUCTION ON COTTAGE SCALE
(CFTRI, Mysore)

Vinegar is commonly prepared from any sugary material with 10-12% sugar content. A wide variety of such materials, e.g. waste fruits, gur, cane juice and wastes from fruit-processing units, are available in rural areas.

The Central Food Technological Research Institute (CFTRI), Mysore, has designed a home-scale vinegar generator suitable for quick fermentation. In this process, the juicy material is fermented to produce alcohol using yeast culture. After fermentation, the clear alcoholic ferment is used for acetous fermentation by the use of mother vinegar culture. The conversion of alcoholic ferment into vinegar can be carried out either by the 'slow process' (5-7 weeks) or by the 'quick process', in which fermentation is brought about in a 'generator'. The average yield from the generator is 8-10 bottles in 24 hr. The vinegar thus obtained is aged, bottled, pasteurized and allowed to settle for sometime. The product is a sparkling clear liquid suitable for table use.

Canning Industries Cochin Ltd, Trichur (Kerala), is producing vinegar from pineapple waste using this technology. The cost of production is about Rs 5 per bottle of 750 ml.

WATER

SAMPLES OF CHLORINE TABLETS, CHLORINE AMPOULES, AND KIT FOR MEASURING RESIDUAL CHLORINE

Water

One of the most serious problems which the rural communities in particular face concerns water, especially drinking water for human consumption and for cattle. Water needed for cooking, bathing, cleaning clothes and other domestic chores is also difficult to come by. Drinking water should be clean, odourless and free from harmful bacterial contaminants. Water-purification methods which rural communities could afford should be inexpensive as well as simple. Water filter candles, which one of the CSIR laboratories has developed, offer such a solution. The filters are to be fitted to earthen pitchers. Not all groundwaters are safe for drinking. Some of them contain excess fluoride, which is injurious to teeth and bones. Here again CSIR has developed a technology to reduce the excess fluoride content.

In rural areas, water is usually obtained from wells, ponds, lakes, rivers, etc. At many places womenfolk have to fetch potable water from far-off places. To lessen the drudgery to women, mechanical devices have been designed and developed to aid rural water supply. Improved hand-pumps designed and developed by CSIR also aid in supplying drinking water.

Rural economy centres on agriculture for which water is the most important factor. The farmer has to take a judicious action to meet his requirement of this resource. Water for agriculture is normally drawn from wells, ponds, canals, etc. through earthen channels up to the farmland. Where the physiographic gradients are not favourable, it is necessary to lift water, lifting being done mostly manually or by bullocks. The traditional manual lifting devices have drawbacks: time-consuming and low output. To overcome these drawbacks, the CSIR has developed novel, manually operated water-lifts. Efforts have also been made to lift water through solar and wind energy. The devices based on solar and wind energies hold forth great promise in small irrigation provided proper attention is paid to the location of the devices and their economics.

In many areas, water in wells and other natural sources is saline because of dissolved salts and other impurities. Such areas have to be supplied with drinking water through tankers, or where this is not possible, womenfolk have to bear the burden of carrying drinking water over tiresome distances. Solar stills which desalinate brackish water offer a plausible solution. While the exploration and utilization of groundwater resources are dealt with in another section, the few examples presented here show how science and technology offers a practical solution in meeting the basic needs of rural communities in regard to water.

27

DEEP-WELL HAND-PUMP, INDIA-MARK II

[MERADO (CMERI), MADRAS]

A deep-well hand-pump suitable for rural community water supply has been designed and developed by the Mechanical Engineering Research and Development Organisation (MERADO), Madras. The work was done in collaboration with the World Health Organisation (WHO) and the United Nations Children's Fund (UNICEF). Prototype of the design was subjected to extensive field tests in water-scarce areas. These pumps are being manufactured under the name 'India-Mark II'. With the emphasis laid on rural water supply programmes in the country, a large number of such hand-pumps have been installed in villages and accepted by people.

The design of the pump has many features:

- Its components are amenable for mass manufacture, thereby ensuring standardization and interchangeability,
- The pump and the hand lever mechanism is such that a minimum of human effort is required to operate the pump.
- Maintenance costs are minimal.
- Attention has also been given to its installation with a proper cement platform and drainage to prevent seepage of surface water into the borewell.

Demonstration and Trials

Extensive testing has been made for about 2000 hr in laboratory and field trials in collaboration with Tamil Nadu Water Supply and Drainage Board at Coimbatore at depths of about 30-40 m.

Training

After the successful development and demonstration of the pumps, UNICEF as collaborators took over the responsibility for its popularization and extension. It is organizing further demonstration of the installation and use of 'India-Mark II' pump.

Adoption of Technology

After successful working of the prototype and extensive field trails, UNICEF entrusted Richardson and Cruddas, Madras (a Central Government undertaking), with the manufacture of 1000 pumps at the first instance. The pumps were distributed to various state and central government agencies responsible for providing drinking water supply. Later, other private parties also started manufacturing the pumps after obtaining the know-how from UNICEF, free of cost.

An Indian Standard (IS 9301-1979) has also been formulated for the 'India-Mark II' hand-pump based on MERADO's design. This enables many entrepreneurs to manufacture the pump without the design/ drawings.

Most of the state government agencies have adopted 'India-Mark II' for drinking water supply for depths of the order of 30 m or more. These agencies buy pumps from UNICEF-recognized manufacturers.

Cost

The pump unit, which consists of three assemblies, costs assembly wise: pump-head assembly, Rs 1200; cylinder assembly, Rs 300; and connecting rod, Rs 40 (per 3 m length).

28

FERROCEMENT WATER-TANKS (CYLINDRICAL)

(SERC, ROORKEE)

The prefabricated components, viz. base, wall and roof units, used in the ferrocement bins of 0.25, 0.5, 1 and 2 tonne capacities can be used as water-tanks of 300, 600, 1250 and 2500 litres capacities respectively. These units, with provision for inlet and outlet pipes and with the inside surface painted with a paint suitable for use on drinking water-tanks, can be used to meet the demands for hygienic water in rural areas. Water-tanks of 250-2500 litres capacity can be produced and erected for use as overhead, surface and underground structures for water supply.

The advantages of ferrocement water-tanks are:

- Unlike steel water-tanks, they are free from corrosion.
- Are lighter than reinforced concrete water-tanks and consume less cement and steel.
- Are cheaper than steel and concrete water-tanks.
- When accidentally damaged, the tanks could be easily repaired.

Demonstrations or trials have been conducted at seven places and exhibitions:

(1)	NOIDA, Village Jhundpura Dist. Ghaziabad. U.P — 1977	Demonstration of production technology of water-storage tanks
(2)	Wardha (Maharashtra) Science for Village Exhibition — 1978	Demonstration of casting and assembling process to rural artisans
(3)	Karimnagar (A.P.) — 1978	Training of artisans and entrepreneurs identified for production technology of water-tanks
(4)	New Delhi-IITF — 1978 NTF — 1979	Water-tank
(5)	Agricultural Exhibition Madgaon (Goa) — 1980	Water-tank
(6)	CHOGRAM-2 Exhibition New Delhi—1980	Water-tank
(7)	Agricultural Fair. PAU, Ludhiana—1981	Components, process equipment for production of ferrocement tanks.

The following entrepreneurial firms were trained in semi-mechanized process for producing ferrocement cylindrical units:

(1) Uttarakhand Concrete Products, NOIDA, U.P.—1978
(2) St Pedro Precast Unit, Panaji, Goa—1979
(3) Indian Concrete Products, Meerut, U.P.—1980
(4) Building Construction and Repair Corporation, Ghaziabad, U.P.
(5) Sukhnidhan Engineering Co., Village Rampur, Channa Dist., Sangroor
(6) Ashok and Associates, Lucknow, U.P.

Adoption of Technology

The technology for producing water-tanks has been released to 16 entrepreneurs and 12 of them are in production.

All necessary raw materials are available in the open market. The process equipment is fabricated by the licensees themselves with the help of detailed drawings provided by SERC. Other items of equipment are easily available in local markets.

29

FILTER AID FA-5 FOR MOBILE FILTRATION UNITS FOR SMALL-WATER SUPPLIES

(NEERI, Nagpur)

Pressure filtration through precoat filters is most suitable for water filtration on a small scale for rural and industrial areas. The popularly used filtration aid for these filters is diatomaceous earth, which, however, is not known to be available in India.

The filter aid FA-5 which the National Environmental Engineering Research Institute (NEERI), Nagpur, has developed is made from wood charcoal powder (50-100 μm) to facilitate widespread use of precoat filters. FA-5 has been found suitable for water filtration without any chemical treatment up to a raw water turbidity of 125 Formazin units (FU). With a raw water turbidity of 20-40 FU, up to two cubic metres of filtered water can be obtained from a 0.46 m^2 septum area while using 1075 $\pm$ 10g of FA-5 per square metre septum area. The filter aid could be reused particularly at turbidity levels of less than 60 FU, 3 to 4 times.

The estimated cost of FA-5 is about Rs 3/ kg as against Rs 10-15 of the imported diatomaceous earth. The cost of filtration is 20-25 paise per cubic metre.

30

PEDAL-OPERATED WATER-LIFTING PUMP

(CMERI, Durgapur)

The Central Mechanical Engineering Research Institute (CMERI), Durgapur, has developed a manually operated pedal pump suitable for minor irrigation in rural areas. The pump can lift water from shallow water reservoirs, such as irrigation streams, open channels, ponds and shallow wells. It can also handle water with mud and other impurities.

The pump weighs about 35 kg. Simple in design, it can be fabricated, installed and maintained even by a small engineering workshop or by village blacksmiths themselves. The raw materials and components required are available indigenously.

Pedal-operated water-lifting for small irrigation

The pedal pump has an average discharge capacity of 6000 litres per hour at a head of 2 m (6 ft) as compared to the popular 'Don' type pump which has an average discharge of 2000 litres per hour at a head of 1 m (3 ft). The pump is operated by a person manipulating his body weight on the foot pedals in a manner which causes the movement of a diaphragm, creating suction in one chamber for lifting water and simultaneously discharging water from the other chamber. The discharge takes place twice in each cycle, resulting in a continuous flow of water. Suitable wooden or steel frames can be provided to support the operator while he is pedalling. A farm of about half an acre can be irrigated in about an hour.

A pedal pump of 87.5 cm × 49.0 cm 57.5 cm size costs about Rs 600, which is far less than the market price.

Demonstrations have been held at six places:

(1) Small Scale Industry Get-together at CMERI, Durgapur (28 Feb. to 3 Mar. 1979); (2) S & M Industries and BITM, Calcutta (8-11 Apr. 1979); (3) Gaon ke Karigar, Science Workshop at Bardoli (Gujarat) (28 Oct. to 2 Nov. 1979); (4) India International Trade Fair, New Delhi (10 Nov. to 9 Dec. 1979); (5) India International Trade Fair, New Delhi (21 Jan. to 3 Feb. 1980); and (6) Banga Sanskrity Sammelan, Bharati Bhavan, Burnpur (9-16 Mar. 1980).

Adequate Casting Corporation (2 Princep Street), Calcutta, are manufacturing and marketing these pumps.

31

RURAL WATER-SUPPLY SCHEME

(NEERI, Nagpur)

Drinking water should be free from disease germs (bacteria, viruses, protozoa) and worms besides being physically clean and acceptable in taste. In any planning of drinking-water supply schemes these are the most important factors to be kept in view. Keeping in focus rural areas, the National Environmental Engineering Research Institute (NEERI), Nagpur, carried out a critical evaluation of representative rural water-supply schemes in eleven states. The objective was to collect reliable data for future planning, designing and implementation of rural water-supply programmes. For the study were randomly chosen different types of water-supply schemes such as hand-pump, tube-wells, and piped supplies with distribution through public standposts and/or house connections. Reference villages were also identified to compare the effect of providing organized water supply on the health status of user communities.

The study showed that the performance of India-Mark II deep-well hand-pump was satisfactory. Bacteriological quality of water supplies obtained from surface sources and open-dug wells was unsatisfactory, while that of tube-wells was better.

Based on the results of the evaluation study, NEERI has made a number of recommendations:

(1) Water supply and sanitation should be treated as a core sector.
(2) This should form a part of an integrated rural development programme.
(3) Smooth flow of construction materials to the implementing agency should be ensured.
(4) Statutory provisions should be made for levy of water tax on the beneficiaries.
(5) Training facilities for operation and maintenance personnel should be established.
(6) Laboratory facilities for water-testing should be established at district levels.
(7) Community participation should be ensured right from the planning stage through the implementation stage to operation and maintenance.

32

SHALLOW-WELL HAND-PUMP

(CMERI, Durgapur)

The quality of shallow-well hand-pumps available in the market being unsatisfactory there is need for frequent inspection and repair. A consequence is that the supply of filtered water in remote villages becomes erratic. To overcome the drawback, the Central Mechanical Engineering Research Institute (CMERI), Durgapur, working in collaboration with WHO and the All India Institute of Hygiene and Public Health (AIIHPH) has modified the design of such hand-pumps. The improved design enhances the life of the pump besides reducing the effort needed to drive it. The investigation report along with the improved design of the pump has been handed over to the AIIHPH/WHO for commercialization or public use.

33

WATER-PROOFING OF SMALL IRRIGATION CHANNELS

(CRRI, New Delhi)

In India, farmers depend mainly on open earthen channels for conveying water for irrigation from a main canal point of their fields. A drawback of this system is that considerable quantities of water are lost during passage through the channels owing to seepage on the way. In predominantly sandy soils, sometimes the seepage is so high that it becomes difficult to convey the water even over short distances. To achieve expeditious and efficient utilization of irrigation potential, it therefore becomes essential to construct proper field channels from the outlet point to the individual fields. Such field channels also enable equitable distribution of irrigation water.

In its attempts to find a solution to this problem, the Central Road Research Institute (CRRI), New Delhi, has found that the permeability of soil can be reduced considerably by mixing the soil with a small quantity of a particular type of bituminous material. The technique was tested in small water-conveying channels and was found to work satisfactorily. Demonstrations of the technique conducted at a few places have testified to its efficiency in reducing seepage of water. Based on the field trials, a simple method for water-proofing of irrigation channels has been developed. The technique consists in applying an intimate mixture of mud plaster and a small quantity of bituminous material in a thickness of about 0.5 in. (1.27 cm) over the sides and bottom of channel, and allowing the plaster to dry.

The steps involved are: removal of vegetation, construction of embankment, trenching the channel, treatment for preventing weed growth, preparation of plaster, plastering the surface, smooth finishing, and allowing the plaster to dry. Any damage caused by rats, rodents and other animals can be repaired by plugging the damaged portion with the same plaster. The treatment is expected to last 4-8 years.

34

WINDMILL—SAIL-TYPE

(NAL, Bangalore)

A sail-type windmill, meant primarily for water-lifting for irrigation in small farms, has been designed and developed by the National Aeronautical Laboratory, Bangalore. A very significant departure in this design is the use of centrifugal pumps in place of piston pumps used generally with small windmills. Centrifugal pumps provide a much higher mechanical reliability and are capable of handling even muddy water. All the necessary step-up gear boxes have been designed so as to keep the system's cost reasonably low, yet achieve high reliability. Tests on fabricated models have testified to the realization of the objective. The rotor is of triangular sail-type easy to furl manually and capable of withstanding gale-force winds through the introduction of flexible members on the rator. Another version with high rotor efficiency is being developed by using a trapezoidal platform in place of triangular sails. With a rotor diameter of 7.5 m, it is a relatively larger windmill compared to several others in the country. This design also offers very high reliability and requires very low maintenance.

The cost is about Rs 20,000.

Trials/demonstration

Under a field-testing programme funded by the Commission for Additional Sources of Energy (CASE) of the Government of India, ten such windmills are being tested around Bangalore.

In another project funded by CASE, ten windmills of NAL's design are under test in coastal locations in Junagadh district of Saurashtra. The project is being executed by the Gujarat Engineering Research Institute, Vadodara.

The NAL's Wind Energy Division has offered consultancy services for fabrication and installation of windmills suitable under high-wind conditions in coastal Gujarat.

NAL has also provided consultancy to the Public Health Engineering Department of the Rajasthan Government in the selection of locations in Jaisalmer district for closer monitoring of wind speeds for deep-well water-pumping. The consultancy study also encompasses matching of windmills with a screw pump.

Sail-type windmill

35

WINDMILL — WP-2
(NAL, Bangalore)

A multivane windmill (WP-2) for water-lifting has been available since early sixties as a result of the work of the National Aeronautical Laboratory (NAL), Bangalore. Of conventional designs, this windmill is comparable to the windmills used in Australia and the USA in cattle ranches. It comprises a 5 m dia. multivane rotor supported in an enclosed housing, which contains bearings, cross-head, connecting rod, etc. The design incorporates the conventional hinged-tail system for regulation and protection against storm and is completely automatic. Connected to a piston pump for water-lifting, it responds to wind speeds of as low as 1 km/hr. It is quite suitable for drinking-water supply schemes in villages, posing practically no problems of maintenance.

Seventy such units installed under a CSIR programme were later gifted to various village panchayats and other agencies. Several of these windmills have operated over the years without an organized maintenance service. The design is more cost-effective in comparison with other multivane windmills in the country. This is not however recommended for use in storm-prone regions.

It costs about Rs 20,000.

Purification

36

BRACKISH WATER DESALINATION BY REVERSE OSMOSIS
(CSMCRI, Bhavnagar)

The heart of the reverse osmosis process is the cellulose acetate membrane, the most commonly used material today. These membranes allow only water to pass through it, though a small per cent of salt also gets into the product water. In addition, they hold back other impurities, including bacteria. At present, cellulose acetate is the most promising material because its salt rejection, although still low, is quite satisfactory for brackish water desalination. A spiral reverse osmosis plant which can produce 10,000 litres per day product water from brackish water has been designed and fabricated by the Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar. The plant, has also been run continuously a year and a half. The plant which operates at about 600 psi on an average, has a product water flux of 6 gal./ft^2 per day with 85% salt rejection.

Although the reverse osmosis technique has been developed specifically for desalination, it has wide potential for separating a solution into dilute and concentrated streams. The applications in which the dilute stream is more important include desalination, water-softening, production of high-purity water, water pollution control, and wastewater recovery. The applications in which the concentrate is more important include concentration of whey, sugarcane juice, other solutions of food products, and solutions utilized in medical and pharmaceutical industries. CSMCRI has already started work on these aspects.

37

DEFLUORIDATION OF WATER BY NALGONDA TECHNIQUE

(NEERI, Nagpur)

Water containing excessive **fluorides** drunk over a period of 8-10 years leads to a disease known as fluorosis in humans as well as animals. In this disease, teeth and bones become soft and brittle and hence incapable of their functions. Such ailments are quite widespread in some districts of Andhra Pradesh, Rajasthan and Haryana where groundwaters contain high concentrations of fluorides.

The National Environmental Engineering Research Institute (NEERI), Nagpur, has developed a simple technique for defluoridation of such waters. It involves addition of alkali (lime, or soda-ash, or sodium bicarbonate), alum and bleaching powder to the water stored in a container with a tap fixed at 3-5 cm above its bottom. Raw water to be used for drinking is put in the container, and the chemicals are added in adequate quantities and the mixture is stirred for about 10 min. The floc formed settles in an hour. The clear supernatant can then be drawn out by opening the tap and stored in another pot. The sediment is thrown away.

Cost

The cost of treatment depends only on the cost of chemicals used. For treating 50 litres of water the cost would be 2-10 paise depending upon the concentration of fluorides to be removed.

Demonstration

The technique of defluoridation of water has been demonstrated in a number of villages in various parts of the country:

(1) Eight villages in Nalgonda Dist. (A.P.).
(2) Six villages in Nandigama Taluqs of Krishna Dist. (A.P.).
(3) One hundred and nineteen villages in Podili, Darsi and Kantgiri Taluqs of Prakasam Dist. (A.P.).
(4) Based on the Nalgonda technique, a large-scale (2270m^3 /day) defluoridation plant was designed and commissioned in November 1980, at Kadiri, Anantapur Dist. A.P., to treat raw water (with 4.1-4.8 mg fluoride per litre to 0.70-1.20 mg fluoride per litre in treated water). The cost of treatment per m^3 was Rs 1.15 or 6 paise a day per person for 50 litres of water.
(5) Twelve villages in Jaipur and Jhunjhunu districts of Rajasthan.
(6) Forty-one habitations in and around Kangayam Union, Coimbatore Dist. (Tamil Nadu).
(7) In addition, demonstration-cum-extension programmes were recommended in five habitations of Pappini and Palayakottai panchayats of Kangayam Union.
(8) Fill and draw-type plants have been designed and handed over to Tamil Nadu government for implementation.

38

DOMESTIC IRON REMOVAL UNIT (DIRU)

(NEERI, Nagpur)

In many parts of the country, especially the eastern region, underground strata contain soluble iron and manganese. These pollute groundwaters and hence well-waters in such regions have a reddish colour and a metallic taste.

Both iron and manganese are harmful whether the water is meant for domestic use or for industrial use. The concentration of soluble iron in polluted water varies from 0.5 to 10 mg/litre. The permissible limit for iron in drinking water is 0.3 mg/litre.

To get round this problem, the National Environmental Engineering Research Institute (NEERI), Nagpur, has developed a simple household iron-removal unit for use in rural areas. In this, water is aerated by passing over a series of coke beds followed by slow-sand filters for removing iron and manganese from such waters. A catalytic oxidation layer is formed in course of time over the coke surface which hastens the conversion of ferrous iron into ferric iron in the water. No chemicals are required. The unit can also be connected to a hand-pump to get iron-free water. NEERI's studies in West Bengal and Kerala have shown that iron from groundwater can be completely removed by such a unit. Villagers can easily adopt this technique to treat the water in homes for drinking as well as all domestic needs such as washing of clothes, cleaning of utensils and bathing.

A unit to treat about 200 litres per hr of water costs about Rs 1000.

39

MULTI-SURFACE SOLAR STILL

(NIO, Goa)

Solar still is a device for desalting saline waters using solar energy. The still helps obtain fresh water out of sea or brackish water at a negligible running cost.

The National Institute of Oceanography (NIO), Goa, has designed and developed a multi-surface solar still. It consists of three major parts: (i) a transparent canopy consisting of a top cover and four side walls each made of ordinary window glass pane; (ii) condensate collection channels, and (iii) a water tray.

The still operates as follows:

It is filled with saline water (15 litres) and exposed to the sun. After a short interval, water vapours start condensing on the inner sides of the canopy. The distillate is collected into channels and led into collectors kept outside the still. The saline water is replenished daily early in the morning. After about two weeks, the inner concentrated brine is totally rejected or dried separately for recovering the salts; the tray is washed and the unit reset for further operation. The surface area of a unit is about 0.5 m^2. When subjected to field trials in monsoon and post-monsoon periods the still gave daily average yields of 1.5 and 2.2 litres respectively. To get substantial yields, a large number of stills need to be operated in parallel either on the terrace of a building or in an open site.

The still can be dismantled, packed and reassembled easily. Breakage of glass sheets poses no problems as new ones can be easily procured from local markets, cut in size, and refitted.

A prototype unit is estimated to cost Rs 300.

Demonstrations/trials have been conducted at four exhibitions: (1) India International Trade Fair, New Delhi (1981, 1982); (2) Plant

Exhibition, Madgaon, Goa (1981); and (3) Plant Exhibition, Panaji, Goa (1981).

Ten solar stills are being fabricated for supply to the Fishery Research Station, Kakinada (Andhra Pradesh).

40

SLOW SAND FILTRATION OF WATER

(NEERI, Nagpur)

Waters obtained from natural surface sources like lakes, streams, rivers, and springs, etc. get contaminated with pollutants arising from human activities and need treatment to make them suitable for drinking. Water-treatment systems to be installed in rural areas should not only be simple to construct and operate but also economical in installation and operation.

One such system is slow sand filtration (SSF), which the National Environmental Engineering Research Institute (NEERI), Nagpur, has found to be more appropriate than rapid-gravity and high-rate-type filters. The SSF technique does not require any pretreatment with chemicals (e.g. alum and/or other polyelectrolytes), which are costly and difficult to procure assuredly and continuously at treatment plants. The technique can remove 99.9% of bacterial load and requires chemical agents like chlorine in very small quantities for disinfection of treated water to make it doubly safe. A number of laboratory and pilot-scale experiments with this technique have been translated into field-scale plants at four villages in the country to work as demonstration units. These units are being managed without any difficulty by local people, and have worked quite satisfactorily, giving water of very low turbidity and low count of bacilli.

The under-drains of one of the demonstration plants (Kamaya-goundanpatte) consisted of a system of PVC pipe manifolds and laterals with locally developed permeable capsules. These were placed at 1.0 m centre-to-centre and topped with a thin layer of pea gravel. This type of under-drain was found to be effective and cheaper than conventional drains.

NEERI's design of SSF plants for treatment of surface waters in rural areas and for serving populations of even up to 30,000 has since been adopted in the states of Maharashtra, Andhra Pradesh, Haryana, and Tamil Nadu. It has been proved that such plants of up to 3500 m^3 per day capacity are more economical than the conventional rapid gravity filters with respect to the annual amortized and running costs.

Guidelines for cost-effective design, construction, operation and maintenance of SSF plants may be had from NEERI.

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TEST KIT FOR MEASURING RESIDUAL CHLORINE

(NEERI, Nagpur)

The National Environmental Engineering Research Institute (NEERI), Nagpur, has developed a test kit for measuring residual chlorine, which is quite handy and cheap. The know-how for manufacturing the kit has been handed over for commercial exploitation. The kit has been found

to be very useful in rural water-supply schemes, where water is disinfected by using chlorine or its compounds.

The test kit costs about Rs 75.

42

WATER DISINFECTION WITH CHLORINE TABLETS AND AMPOULES

(NEERI, Nagpur)

Villagers normally draw their water supplies from open wells which are prone to pollution. Water from shallow tube-wells also gets polluted because of seepage of wastewater in the vicinity of tube-wells and hand-pumps. Water collected by villagers from water stands and ponds in pots very often gets contaminated owing to unclean and improperly washed utensils and lack of personal cleanliness and hygiene. Because of the use of polluted and unsafe water for drinking, water-borne intestinal diseases are quite common amongst villagers. So that villagers could easily obtain drinking water from contaminated water the National Environmental Engineering Research Institute (NEERI), Nagpur, has developed chlorine tablets and ampoules for disinfecting stored water in pots. These can also be used in hospitals, dispensaries, hotels, railway stations and such other places where safe potable water is not available.

The tablets are of four sizes, each providing a fixed range of chlorine in the quantity of water to be treated. The specifications (IS: 9825-1981) are as follows:

Mass of tablets g	*Amount of chlorine* mg	*Volume of water* litres
2.5 ± 0.125	300 ± 60	240
0.5 ± 0.025	25 ± 5	20
0.25 ± 0.013	5 ± 1	4
0.125 ± 0.005	1.25 ± 0.50	1

The dissipation of chlorine is gradual. For quick dissipation, tablets may be powdered before adding to the recommended quantity of water. Slow stirring for a minute or so is advisable to achieve uniform distribution of chlorine in water.

The shelf-life of the chlorine ampoules, stored in a dark place, is two years. An ampoule gives 5 mg chlorine per ml. These are available in 1,5,10 and 20 ml capacity to serve the requirement of individuals and large families. Chlorine solution is also available in amber-coloured bottles.

With unknown water, it is desirable to add 2 mg chlorine per litre of water or even more where pollution is suspected. Water treated in this way may be allowed to remain for at least 30 min. before use.

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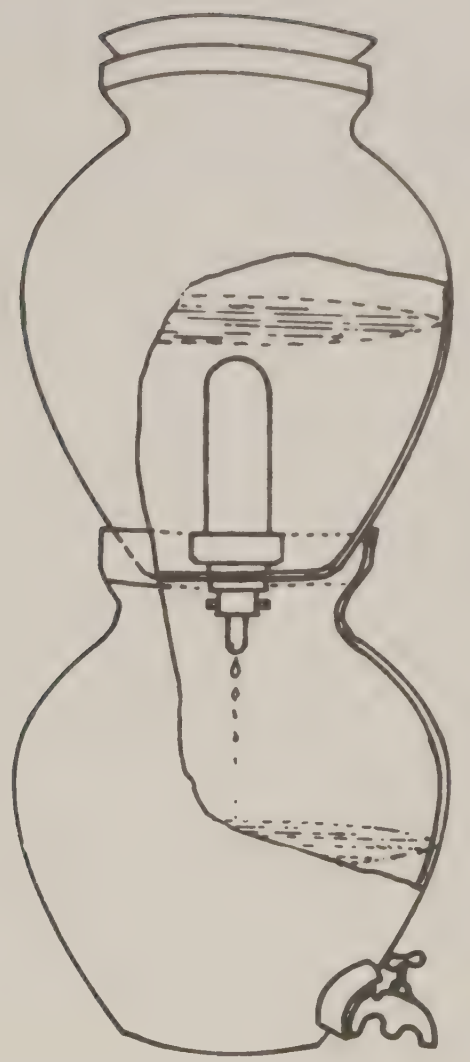
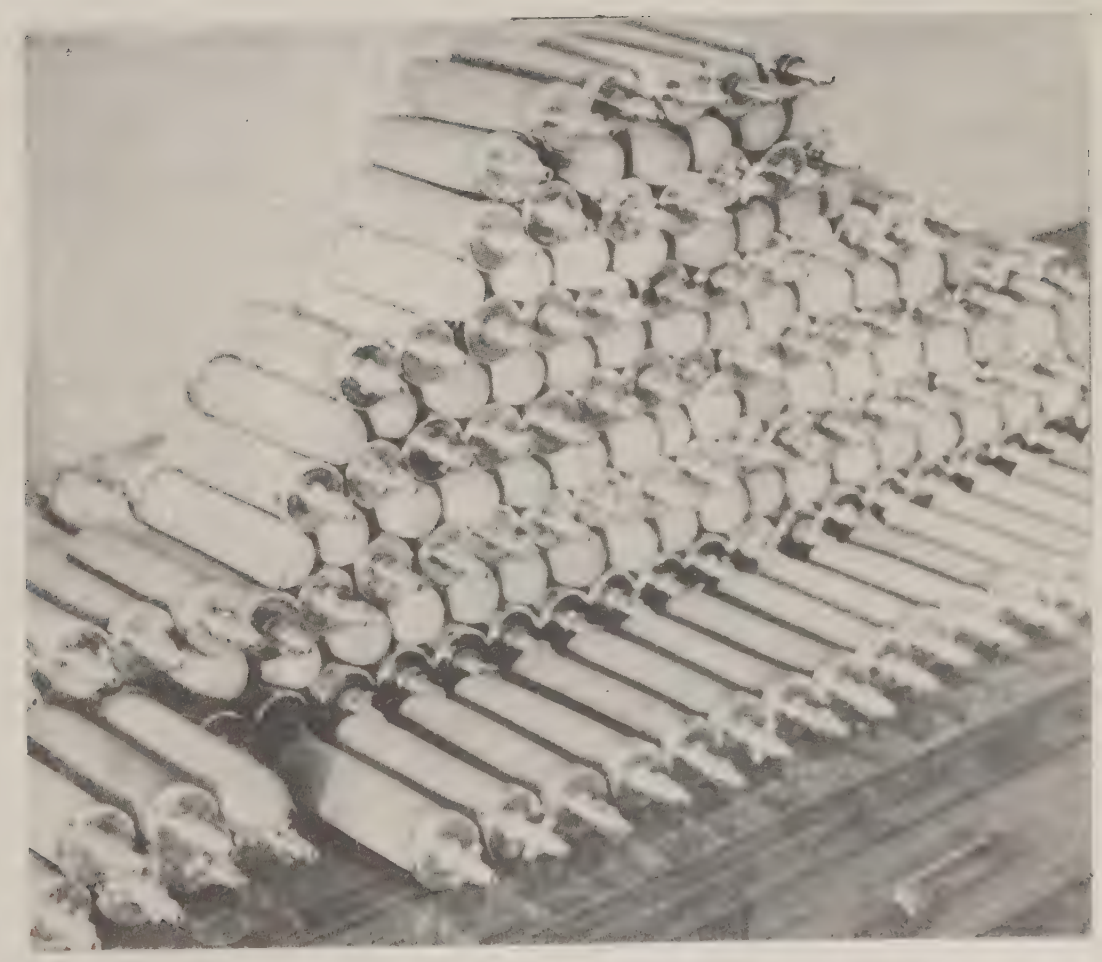
WATER FILTER CANDLES

(RRL, Jorhat; CGCRI, Calcutta)

Raw water from many sources contains harmful bacteria which could cause water-borne diseases such as cholera and typhoid. The bacteria need to be killed to make the water potable. If treatment at source is



Water-filter candle fitted in an earthen pitcher



Stack of water-filter candles

not adequate, it is advisable to process water in each household before drinking. One method of treatment at home is to filter water through beds of sand, gravel and charcoal to remove suspended impurities, followed by boiling to kill the harmful bacteria. This treatment, though efficient, is costly and time-consuming. It can be simplified by using a simpler filter candle which filters water instantly.

For manufacturing such water filter candles, two CSIR laboratories, viz. Regional Research Laboratory, Jorhat, and Central Glass & Ceramic Research Institute (CGCRI), Calcutta, have developed processes. The candles can be fitted into domestic water containers, including earthen pitchers, to meet the daily water requirements of an average family. The candle gives clear water by removing suspended impurities and bacteria. Cheap and convenient to use, these candles are becoming increasingly popular.

Experiments were carried out by NEERI, Nagpur, to test the efficiency of the filter candles in the removal of coliform group of microorganisms, which are the indicators of faecal contamination. The tests showed that the well-water samples of filtered water were free from coliform germs. Experiments conducted on the longevity of the filter candle revealed that even after filtering 500 litres of well-water (nearly 80 cycles) continuously, the candles had not suffered in efficiency, as filtered water was free from coliform. The candle costs Rs 25-30 a piece.

Seventeen trials at RRL, Jorhat, and five at CGCRI, Calcutta, have been conducted.

The RRL, Jorhat, technology has been licensed to 17 parties and two of them have gone into production: (1) Vijay Chemical Industries, Jorhat; (2) Ceralain Filters Pvt. Ltd, Pune.

The CGCRI has licensed the process to 11 parties, two of them going into production: (1) India Potteries Ltd, 91 Dharmatala St, Calcutta 700 013; and (2) A.K. Sircar (Industries) Pvt. Ltd, 32/1 Dalhouse Square, Calcutta 700 001.

These CSIR laboratories can supply the list of suppliers of raw materials, chemicals and equipment.

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WATER PURIFICATION WITH CHLORINE TABLETS FOR INDIVIDUAL USE

(NEERI, Nagpur)

More than 25% of the rural population go for agricultural work in farms away from their habitat. A farmer, on an average, drinks more than 3 litres of water during the day's work. The farm workers do not carry water to the field and hence have to depend on waters available at places of work. To provide them with disinfected/safe drinking water, the National Environmental Engineering Research Institute (NEERI), Nagpur, has developed small-size chlorine tablets for individual use. These tablets can disinfect water in a small jar, bucket or pot used in fields.

One has to wait for about 20 min. after adding the tablet to water in the container so as to allow the required contact time after which the

water is safe for drinking. The amount of the chlorine tablets and the volume of water it can treat are:

Tablet mass	*Volume of water*
0.125 ± 0.005 g	1 litre
0.250 ± 0.013 g	4 litres

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SOLAR WATER STILLS FOR COMMUNITY USE

(CSMCRI, Bhavnagar)

There are many areas in the country where underground/surface water is brackish (saltish). People in such areas have necessarily to depend on supply of water through tankers or fetch it by walking long distances. To provide drinking water to communities living in such areas, the Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar, has designed solar stills. The still consists of a closed chamber with a sloping glass cover. On distillation, saline water is converted into potable water fit for human consumption.

Solar stills are simple to construct, operate and maintain as they have no moving parts. Moreover, the clean glass covers offer a good surface for rain-water collection. The still can also be used for producing distilled water for testing and analytical applications and for topping automobile batteries. As the still operation depends totally on solar energy, the quantity of desalted water produced varies with the season; it is higher during summer and lower during winter. The diffuse nature of solar energy is also a deciding factor in the production efficiency. The annual average output of desalted, potable water is 2-3 litres per day per square metre area.

The designs developed by CSMCRI are amenable for permanent as well as semi-permanent types of construction. Also, both types of constructions can be modified for installing solar stills on ground or on terraces. Construction materials are those that are commonly used in building construction. Large-size solar stills need to be erected at the site as it is not possible to transport an assembled unit. Extensive studies have shown that solar stills are suitable for the country in supplying drinking water to isolated communities—small villages in desert areas, lighthouses and salt-works where the water requirements are less than 5000 litres per day, and where other local alternatives are not possible. There should be a sufficient open area depending upon the capacity of solar stills and source of brackish/saline water. Brackish water is placed in a chamber of solar still to a depth of 5 cm. Sun rays falling on the water vaporize it and the vapour on contact with the glass cover (inside) condenses into water. The drops of water that trickle down are collected in a channel from which it comes out by gravity. CSMCRI has not only designed many stills, it has also assisted in their installation. One such still (installed) at the Navinar lighthouse supplies drinking water (130 litres/day), and another at the Engineering Research Institute, Baroda, supplies distilled water (80 litres/day). Stills have also been installed in some villages of Gujarat and Rajasthan. A still has been installed in Lakshadweep. During the last few years, quite a good number of small solar stills have been installed for producing distilled water in capacities ranging from 100 to 800 litres/day.

Solar distillation plant at Narayana Sarovar in Kutch; consists of 45 solar stills and has a capacity for supplying 2400 litres of fresh water daily.

Desalted water obtained from solar stills is a bit costlier than the conventional municipal water. But it has its own merits in places where there is no source of fresh water in the vicinity.

The cost of installation depends upon the total area of solar stills, i.e. capacity of plant to obtain the desired product water, the average cost being about Rs 350/m^2 area.

CSMCRI helps interested parties in setting up solar stills by supplying design and drawings and also by training personnel.

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WATER SUPPLY FOR DRINKING—MOBILE DESALINATION PLANT

(CSMCRI, Bhavnagar)

Desalination of brackish or saline water is of great importance in places where there is acute scarcity of fresh water. The reverse osmosis technique has emerged as a major breakthrough in the realm of water desalination. The simplicity of operation and low capital costs as compared to other desalination techniques are its main attractive features. In this process, saline water flows under pressure over a polymeric membrane which allows only water to permeate through, restricting the passage of all the dissolved salts. The heart of the process is the membrane whose efficiency depends largely on its ability to reject as much of salt as possible and at the same time possess high permeability to water.

Based on the reverse osmosis principle, the Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar, has fabricated a mobile desalination plant for providing drinking water to villages where

groundwater is brackish. The plant has a capacity to produce 10,000 litres of potable water daily (24 hr operation) and is mounted on a bus. The capacity can be increased to 20,000 litres a day by incorporating additional modules for which space has already been provided in the design.

To demonstrate the feasibility of the technology as well as to create an impact on the public, CSMCRI has taken the mobile plant to several villages where such plants would be a boon.

Equipped with automatic controls, the plant does not require constant attention. The membrane used in the mobile unit has a salt-rejection capacity of 80-85% with a potable water output of 250-300 litres per m^2 per day.

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WATER-TREATMENT PLANT-PACKAGE

(NEERI, Nagpur)

The need for prefabricated water-treatment plants is invariably felt in Indian villages, where surface waters are used. River waters carry suspended matter, particularly during rainy season, and require treatment before use. A compact water-treatment plant suitable for rural conditions has been designed and developed by the National Environmental Engineering Research Institute (NEERI), Nagpur. This plant has three concentric cylindrical compartments; the innermost is the flocculator unit, the outermost acts as a filter, and the central compartment is a hopper bottom sedimentation basin. The flocculator is equipped with paddles. The alum solution is fed by a constant-head gravity device. The flocculated and settled water is filtered. A bleaching-powder solution is added to the flocculated water before it flows into the sedimentation basin. As a result, there is adequate contact time for disinfection, and the sedimentation basin and filter are free from organic fouling.

Rural water supply package plant

The picture shows tube-well, storage tank, treatment and supply at convenient points in a village near Nagpur.

The plant was operated continuously for a year and data were collected using Kanhan River water with a turbidity range of 20-1900 NTU. The alum dose ranged from 7 to 200 mg/litre. The physico-chemical characteristics of treated water conformed to the standards for drinking-water. The skill available in the villages was adequate to operate and maintain the plant. The power consumption was nearly one unit per cubic metre of treated water and the estimated cost of treatment per cubic metre was Re 0.50-Re 1.00.

48

WELL-WATER DISINFECTION BY POT CHLORINATION

(NEERI, Nagpur)

In a number of villages, dug wells are the only source of drinking-water. These are usually contaminated, the water being unsafe for drinking. A continuous chlorination system developed by the National Environmental Engineering Research Institute (NEERI), Nagpur, gets round the problem of drinking water contamination.

The system works as follows:

A plastic pot of 5-litre capacity with a cover (available in any market) is filled with gravel of 2.0-2.5 cm size to a height of 5 cm from bottom. A mixture of bleaching powder and coarse sand (1:4 by wt) is placed on top of gravel to about an equal height. Two half centimetre diameter holes are made in the cover of the pot, which is put in a stout wire-cage and hung at the centre of the well to be disinfected. The length of the rope for hanging the pot is so adjusted that the pot remains submerged in water to a depth of about a metre. The chlorine from the bleaching powder in the pot oozes out slowly so as to maintain a residual concentration of about 0.5-0.2 mg per litre for a period of about a week, when the draw-off rate from the well is about 1200 litres per day.

Well-water disinfection by pot-chlorination

Pot-chlorinator

The system has been found to last 7-10 days after which the mixture needs to be renewed so as to keep a residue of about 0.2 ppm of chlorine in the well-water, which is sufficient to disinfect it.

Cost

The technique of disinfection is simple and economical and has been accepted by many villages. The estimated cost of pot is Rs 25 which includes the costs of cage, rope, one change of bleaching powder, and sand.

HEALTH AND FAMILY WELFARE

TRIBAL PEOPLE AFFECTED WITH GOITRE DUE TO IODINE DEFICIENCY

Health and Family Welfare

It would be a truism to say that health and family welfare is of primordial importance to the progress of any society. Socio-economic and cultural factors play a major role in improving the health status of individuals. In the rural context, special attention is needed for child welfare, prevention of diseases, population control and rehabilitation. The technological advances made in these fields need to be utilized for human development, keeping in view the socio-economic and cultural background of the rural populations. The measures to be used ought to be in the form of prevention and cure of diseases to safeguard the health of infants, pregnant and lactating mothers and aged people. The CSIR's specific S&T programmes in this sector were, therefore, directed to meeting these needs. Malnutrition, for instance, continues to be a serious public health problem of far-reaching socio-economic implications in rural and backward areas. One of the major obstacles lies in the food belief systems of the rural folk. S&T recipes arising from CSIR laboratories' researches to solve the problem are nutritious supplements, fortification of common salt, supplementation with vitamins, etc. Studies on foods causing deformity, night blindness and other ailments have also been carried out. Research in progress towards finding ways and means of checking the alarming rate of population growth have also yielded satisfactory solutions in the form of contraceptive devices.

49

CERVICAL DILATOR (ISAPTENT)

(CDRI, Lucknow)

The explosive population growth in developing countries sets at naught their governments' efforts to raise the standard of living of the people. Hence the primordial importance of family planning programmes. One of the measures to restrict unwanted birth is the termination of pregnancy, cervical dilatation and other gynaecological operations. Aiding in this measure is 'Isaptent', a device developed by the Central Drug Research Institute (CDRI), Lucknow. The device provides the appropriate cervical dilatation in about 5 hr.

Isaptent is cheaper and better than Laminaria tent, an imported material currently used for dilatation. The CDRI device is made from the seed husk of *Isapgol (Plantago ovata),* an agricultural product abundantly available in India.

Isapgol seed husk is granulated and compressed into cores of appropriate size, which are encapsulated in cloth tubes either lined inside with desized paper or coated with a thin film of microcrystalline cellulose. These tubes are then compressed, packed in glass or polythene containers, and sterilized under gamma radiation.

The raw materials required are: *Isapgol (Plantago ovata)* seed husk, gum acacia, cellulose powder, fine cloth, and cotton or polyester thread.

The equipment needed include: a core-making machine similar to a tablet-making machine but with a different die; a sewing machine; an oven, a grinder; a gamma radiation chamber, and a compressing machine.

Adoption of Technology

The technology has been released to Unichem Laboratories Ltd, Bombay, which is manufacturing and marketing it under brand name Dilex-C.

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IODIZED SALT FOR GOITRE CONTROL

(CSMCRI, Bhavnagar)

To maintain good health we need minerals and other trace elements, for example iodine, in the diet. Insufficient quantities of iodine in the normal food enlarge the thyroid gland, leading to a deficiency disease known as goitre. Recent estimates show that about 120 million people in India suffer from goitre.

So far, the most satisfactory medium developed for iodine intake is salt. To meet this need of the masses, the Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar, has developed a simple and labour-intensive process (submersion method) for manufacturing iodized salt.

The process involves submersion of solar salt in saturated brine containing a sufficient quantity of calcium iodate, followed by draining or centrifuging. The necessary level of iodine in brine is maintained to get 15 ppm of iodine in iodized salt (IS: 7224). By this process, iodine is distributed uniformly and is more stable.

The process can be adopted on a cottage/small scale of 1-10 tonnes/day. A mechanical plant for a capacity of 100-200 tonnes/day could also be set up.

Continuous iodization by the submersion process with a capacity of 100 tonnes per shift require an investment of about Rs 6.0 lakh. In the case of labour-oriented submersion process (cottage scale), investment cost will vary with the capacity of production and cost of raw materials available. The process has been released to four parties.

51

LAXATIVE FROM ISAPGOL

(CDRI, Lucknow)

Isapgol (Plantago ovata) seed husk is a well-known bulk laxative, but the raw husk has a bland taste. The Central Drug Research Institute (CDRI), Lucknow, has developed a formulation of the husk which is much more acceptable because of its taste and flavour. The formulation is prepared as follows:

Isapgol seed husk is freed from foreign impurities, granulated by mixing with alcohol or gum acacia solution, and dried. The granulated mass is finely powdered to 40-60 mesh size. The sieved material is mixed with appropriate sweetening and flavouring agents. The product thus obtained may be mixed with any other laxative or effervescent powder. The product can be used as a household remedy for constipation. It is safe and is free from side-effects.

The raw materials required are: *Isapgol* seed husk, sugar, alcohol, gum acacia, sodium bicarbonate, citric acid, tartaric acid, malt extract and flavouring agents.

The items of equipment needed are: mixing pan, vacuum oven/drier, grinder, and sieve.

52

OCCUPATIONAL AND ENVIRONMENTAL HEALTH

(ITRC, Lucknow)

The Industrial Toxicology Research Centre (ITRC), Lucknow, has been engaged in the study of the toxicological effects of agro-chemicals and particulate air pollutants. Its studies also encompass effects due to inhalation of hays, husks, and agro-organic dusts in rural areas. The emphasis has been on the monitoring of the effects of various chemicals in humans. The assessment of the effect of the widespread use of insecticides, pesticides and weedicides on farm workers and their environment has assumed significance. The results have helped in working out therapeutic measures to relieve and cure the suffering and drudgery to human beings.

Paralytic Diseases

The ITRC studies have shown that the paralytic disease spreading in villages has a complex aetiology and origin. It has been identified, for the first time, as subclinical lathyrism. The result was the occurrence of a paralytic disease. It was noted that the endemic paraplegia in the

affected villages was due to ingestion of 'matri' dal as well as drinking of manganese-contaminated water. Affected persons have generalized normocytic normochromic anaemia. Based on this study, ITRC recommended (i) withdrawal of all seed-stock of 'matri' legume and substitution of its cultivation with alternative legumes; and (ii) good potable water with only permissible limits of manganese.

This study has helped in the assessment and abatement of environmental health problems in rural communities.

Impact of Organochlorine Pesticides

A large number of pregnant women in rural as well as urban areas undergoing (i) spontaneous abortions, (ii) premature labour, and (iii) full-term labour were screened for the presence of organochlorine pesticides. The results were astonishing: All still-births examined for the presence of pesticides in the maternal blood, placenta and umbilical cord blood were found to be highly contaminated with the pesticides. The study has helped establish relationships between nutrition and infection and toxicity of various chemicals in humans.

Occupational and Environmental Problems

Data have been collected on predictive toxicological evaluation of various substances, embryo toxicity, occupational ailments, and behavioural effects in rural settlements. The study has shown that for facing such toxicological hazards, constant and effective medical surveillance and follow-up are essential. The study has also spelt out the need for reforms to protect the workers in the unorganized sector against potential hazards from chemical and physical factors in the working environment. The study also underscores the need for personnel protection measures like the use of gloves, masks, and protective clothes; besides provisions for washing, ventilation, periodic medical check-up, and health education. The need for protecting women workers especially from occupational and environmental hazards is also apparent.

Occupational Health Hazards

Much of the work-force employed in small-scale and cottage industries is exposed to several occupational health hazards. Health surveys have also been conducted on agate stone-cutters, flour-mill workers, textile workers, railway porters, and workers engaged in electroplating and welding operations. The results again underline the need for precautionary measures.

An outdoor Occupational Health Centre is run by ITRC under an Employees State Insurance Scheme in cooperation with the Department of Medical and Health Services at Kanpur. The clinic examines suspected cases of occupational diseases of a diverse variety and intensity that are referred to them by various industries located in Kanpur.

ITRC also organizes periodically training programmes on environmental and occupational health problems. The main objectives of such programmes is to highlight various environmental problems and occupational hazards affecting the health of industrial workers. One such programme was held from 4 to 7 November 1982. It was attended

by 45 medical and para-medical employees of various government and private sector undertakings, out of which 25 medical officers from various ESIS hospitals were nominated by the Department of Medical and Health Services, of the Uttar Pradesh government. Besides, officers from various other institutions participated in the programme.

The ITRC training programmes cover :

- occupational and environmental problems in rural communities and small-scale industries;
- environmental monitoring (principles, methods, equipment, designing surveys, and presentation of results; etc.);
- epidemiology surveys (principles, methods, observations, work physiology);
- protection of workers and industrial medicine;
- socio-economic aspects including creating awareness;
- industrial toxicology (predictive and preventive);
- toxicological information service and legislative and regulatory aspects;
- early detection and cure of industrial health problems;
- environmental health problems;
- visits to cottage and small-scale units.

SANITATION AND ENVIRONMENT

A WOMAN OPERATING WITH EASE A DEEP-WELL HAND-PUMP (INDIA MARK II) INSTALLED IN A VILLAGE BANGARUPETTAIN, CHINGLEPUT DIST. (TAMIL NADU)

Sanitation and Environment

Providing sanitation and preserving a healthy 'environment' in villages, which are the abode of nearly three-fourths of the country's population, is the most essential prerequisite for preserving the health and welfare of the nation. In the context of rural development, what needs attention is the land, water, flora and fauna, humans and cattle. The deterioration of resources due to unplanned harnessing of land, water and forests in the past is becoming more and more obvious. This calls for immediate action for environment conservation, preservation and protection. Efforts have therefore been directed in recent years to rectify the past mistakes in order to provide a better future for the countryside. Another aspect of environment is sanitation, i.e. how a clean and healthier environment can be provided to people in their own settlements and in tackling the existing environmental problems associated with sanitation in villages. This consists of providing potable water, and sanitary disposal of human excreta, garbage, animal dung, sullage and storm water. To be successful, R&D solutions, of which CSIR's are many, alone are not sufficient. It is equally necessary to educate the rural masses on the need for adopting hygienic practices — practices which need not be in conflict with the cultural mores and which are within the economic means of the communities. Such education can be provided through audio-visuals; on-the-spot live demonstration can also achieve the purpose. Another measure which could take deep roots in the countryside in regard to the adoption of simple technological tools to improve sanitation and environment is collective extension work village-wise.

Pollution and toxicological hazards are of national, if not of global, concern. In the rural context, these relate to the dangers of the use of pesticides in crops, use of insecticides and rodent control chemicals for storage of food grains, and contamination of food articles with harmful chemicals. CSIR laboratories have not only developed techniques of detecting toxicological products, but have also developed safer insecticides, and methods of their application, safer food colourants and additives, etc.

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FERROCEMENT MANHOLE COVERS

(SERC, Roorkee)

The tests conducted on light-duty and medium-duty ferrocement manhole covers have shown that these covers can take the loads specified for cast-iron manhole covers in IS:1726. These covers have been provided with mild-steel flat edges around to prevent edge breaking. The skeletal steel bars are directly welded to the edge frame. No major equipment is needed for production. The cover is vibrated under pressure by using electrically operated vibrators, and needs good quality control.

Ferrocement manhole covers are 15 to 25% cheaper than cast-iron manhole covers. Production of cast-iron covers requires a large quantity of fuel (coal) and power, which are not required in the case of ferrocement covers.

Demonstrations on ferrocement manhole covers, light - as well as heavy-duty, were conducted at the Agriculture Fair, Punjab Agricultural University, in 1981.

Training courses in production and testing of these covers were organized for polytechnic teachers and field engineers in 1979 and 1981 on behalf of the Institute of Engineering and Rural Technology, Allahabad.

A light-duty rectangular cover (455mm×610mm×25mm thickness) costs about Rs 45.

A medium-duty circular cover of 500mm diameter costs about Rs 140.

54

FERROCEMENT SEPTIC TANK

(SERC, Roorkee)

Septic tanks provide the most effective system for disposal of human excreta for populations that cannot afford the high-cost sewerage system. Moreover, for most rural areas septic tanks are the only possibility. Septic tanks constructed at present are rectangular in shape but circular septic tanks have been found to be equally efficient. In circular tanks, greater economy could be achieved by reducing the consumption of materials. The circular or rectangular septic tanks constructed with brick masonry are not 100% water-tight and require a large area. Another drawback is that the effluent quality deteriorates with time. If ferrocement is used as construction material in septic tanks, such tanks have the advantage of being impervious to water.

The Structural Engineering Research Centre (SERC), Roorkee, has developed techniques for casting and assembling precast components of vertical circular septic tanks. The shapes and sizes of such units have been worked out from functionally tested designs developed by public health engineers from the Uttar Pradesh Jal Nigam. In the design adopted, the septic tanks are made of two precast units: (i) a sludge digestion chamber, and (ii) a de-sludging pit.

Salient Features

- Ferrocement septic tanks are slightly cheaper than brick masonry septic tanks.
- Fully precast, transportable units can be produced to serve up to 25 users.
- Reduce installation time.
- Good-quality manure obtainable from de-sludging pit.
- No need to close to remove sludge.
- Fully water-tight construction.
- Minimum chances for choking due to sludge deposition.
- Ideal for use in rural areas, hilly areas, and in areas where good-quality bricks are not available.

Economics

Capacity	Cost Rs	
(No. of users)	Digestion chamber	De-sludging pit
5	600	350
10	900	350
25	1500	450

The ferrocement septic tanks are being manufactured by many of the 17 entrepreneurs who have been given the know-how. The Uttar Pradesh Public Works Department and Uttar Pradesh Jal Nigam have used the ferrocement septic tanks in some of their projects.

Ferrocement septic tank

55

HAND-FLUSHED WATER-SEAL LATRINE

(NEERI, Nagpur)

In most of the rural areas, there are no latrines of any kind and the common practice is to go out and defecate in open fields. This practice not only causes foul odour polluting the atmosphere, but also contaminates the soil and the groundwater, particularly during rainy season. A serious hazard, as a result, is that water-borne intestinal disease germs continue to recycle through the drinking water and sickness morbidity perpetuates in rural areas.

To eliminate this health hazard, the National Environmental Engineering Research Institute (NEERI), Nagpur, has designed a hand-flushed water-seal two-pit latrine. Human excreta contained in covered pits is non-accessible to storm-water runoff, insects, house-flies, etc. Pathogens in the excremental matter die a natural death because of unfavourable external conditions during long storage periods in the pits.

The NEERI design consists of a squatting enclosure and two digestion-cum-soakage pits connected through a junction chamber. In the squatting area, a cement mosaic finish pan and a trap with 20mm of water-seal is fitted to collect and transfer faeces to a connected pit. The faeces along with the ablution water and flushing water flow into the pit. While the water is soaked by the soil, the faeces are digested anaerobically. This produces humus (ranging between 50 and 60 kl per person per year), which is rich in fertilizing elements like nitrogen and phosphorus. It may take 2-3 years for a five-member family to fill up a pit of 1 m dia. and 1.25 m effective depth. Since the soaked water may

Rural latrine: low-cost superstructure constructed by using panels of brick on edge with a simple asbestos-cement-sheet shutter

transport bacterial and chemical contaminants to the groundwater, the bottom of the pit is kept at least 1.8 m above groundwater level, and the safe distance between latrines and wells in the vicinity between 5 and 15 m, depending upon the texture and the size of the particles in the soil around.

When one of the pits is filled up, it is disconnected from the latrine and the other pit is connected through the bifurcation chamber. The contents of the first filled-up pit are taken out after about 2 years and the pit is prepared for reuse.

The estimated cost of a latrine unit without the superstructure is about Rs 500 (1983). The cost of superstructure, depending on the design and specifications, ranges from Rs 250 to 800 per unit.

Under its rural sanitation pilot project carried out in 10 villages around Nagpur, the institute has constructed 1200 such latrines (up to the end of 1983).

NEERI has also been training village masons sponsored by rural development departments and voluntary organizations to cast cement concrete latrine pans and traps as designed. The institute supplies, at cost, moulds for making them.

The cost of the cement concrete pan and trap is about Rs 40 per set, whereas other types available in the market cost from Rs 100 to 125 each.

The technology has been adopted on a large scale by several government departments and municipal corporations. The Water Supply and Sewerage Board of the Maharashtra government has taken up a state-wide programme for converting the existing service latrines into the new system so as to relieve scavengers of this obnoxious drudgery. The programme is in progress in 200 towns.

Rural latrine in construction; on the left is seen septic tank

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HAND-OPERATED KNAPSACK-TYPE INSECTICIDE SPRAYER

(MERADO, Ludhiana; CMERI, Durgapur)

A hand-operated knapsack-type insecticide sprayer has been designed and developed by the Mechanical Engineering Research and Development Organization (MERADO), Ludhiana. The sprayer consists of a tank in which the spray liquid is carried; a piston-type pump, which delivers the liquid from the tank to the nozzle at a required pressure; an air pressure chamber, which makes the liquid flow continuously; and a nozzle which determines the spray pattern and range of spray droplet sizes. The cut-off device fitted in the discharge line controls the flow of the spray liquid to the nozzle. A part of the spray liquid under pressure is fed to the tank for agitating agro-chemicals. The sprayer is provided with a woven web cotton belting which is strapped to the back of the operator. The chemical to be sprayed is stored in the tank and the sprayer is strapped to the back of the operator. The pump is operated with one hand and the cut-off device along with spray-lance and nozzle is held in the other hand. The operator moves forward and directs the flow of the spray liquid to the target.

Hand-operated knapsack-type insecticide sprayer

The sprayer has several salient features:

- Replacement of conventional brass tank with a low-priced easily available standard polythene tank.
- Provision of different tanks to be used for spraying different types of chemicals.

- Enhancement in the capacity of the air pressure chamber by incorporating it outside the tank, which makes the spray continuous and more uniform by reducing pressure fluctuations.
- Provision of pump operation either with left or right hand depending on the choice of operator.
- Leverage designed for smooth and comfortable operations of the pump.
- Saving of about 20% on the cost of the conventional brass sprayer.

Specifications

Tank capacity	16 litres
Pump cylinder inner dia.	36 mm
Stroke length	55 mm
Air pressure chamber capacity	800 ml
Working pressure	3 kg f/cm^2
Nozzle discharge rate	450 to 800 ml/min.
Overall size	750 × 410 × 560 mm
Net weight	7 kg

The unit costs about Rs 400.

Demonstrations and trials were conducted at three exhibitions: Industrial Exhibition at G.N. Engineering College Campus (Ludhiana-1978); Exhibition at Centre of Science for Villages (Wardha-1978); and India International Trade Fair (New Delhi-1979).

One industry is manufacturing the sprayer: Sigma Steel Industries, A-2, Industrial Estate, Ludhiana-141 003 (Punjab).

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NIGHT SOIL UTILIZATION — INTEGRATED SYSTEM

(NEERI, Nagpur)

The National Environmental Engineering Research Institute (NEERI), Nagpur, has designed an integrated system for total utilization of night soil. The system works as follows:

The effluent slurry from the night soil digester is fed into shallow sand beds. The clear water percolates down and collects in small ponds. The solid material collected over the bed is scrapped and used as manure. Blue-green algae are grown in the pond and fed back to the digester, thereby increasing the biogas yield by 20-25%. Thus there is total utilization of night soil.

The cost of the integrated system depends upon the size of the unit.

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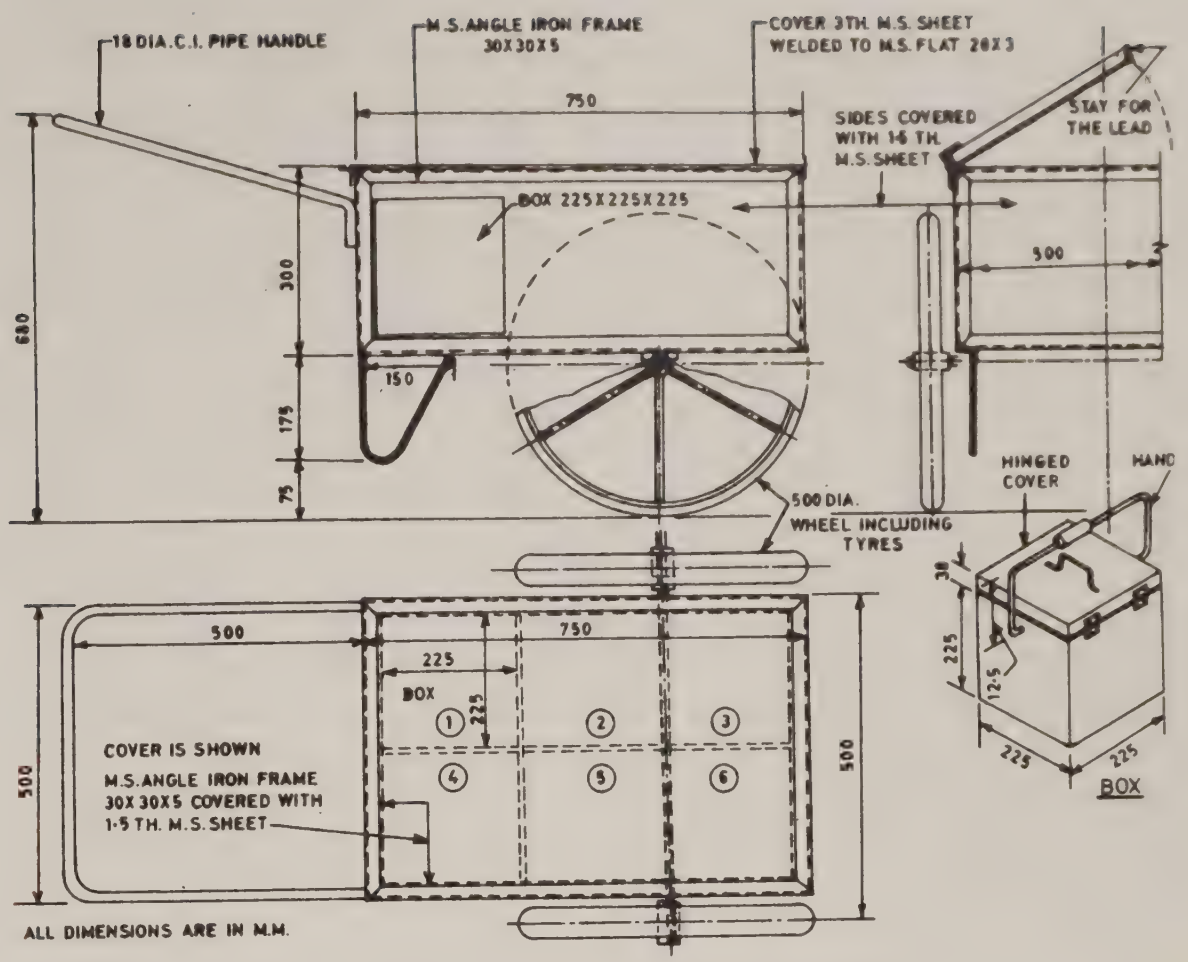
NIGHT SOIL WHEEL BARROWS

(NEERI, Nagpur)

The use of wheel barrows eliminates the drudgery of carrying the night soil as head load in the locations served by 'dry conservancy' system. Four different types of wheel barrows have been finalized for extension, and the designs are available from the National Environmental Engineering Research Institute (NEERI), Nagpur.



Design drawing of a night-soil wheel-barrow

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RURAL LATRINES
(CBRI, Roorkee)

More than 90% of rural households do not have proper latrines. The main hurdles are: the cost of putting up the facility even at community level, its maintenance, and a rational construction design with a cheap and durable superstructure. As a solution to this problem, the Central Building Research Institute (CBRI), Roorkee, has developed a system suitable for rural use. It consists of 100cm×80cm hand-flushed water-seal latrines with two leaching pits of 1 m^3 capacity each. One pit is to be used at a time and the other is kept in reserve. A pit lasts 48 to 72 months after which the second pit is connected to the latrine and the first one cleaned. The night soil changes into a useful manure during this period and the manure can be removed by the owner and used in fields and vegetable gardens.

Fourteen demonstration latrines, built during 1981-83, are functioning satisfactorily. Demostrations were also conducted at three places during 1983, and a number of lectures delivered.

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SEWAGE FARMING BIOTECHNOLOGY
(NEERI, Nagpur)

Realizing the economic potential of wastewaters in agriculture and of the efficacy of land application of wastewaters as a means of preventing environmental pollution, the National Environmental Engineering Research Institute (NEERI), Nagpur, started research on safe and optimal

utilization of wastewaters for crop production. Its laboratory-scale as well as field investigations have yielded valuable data. Set out below are the salient features and conclusions of the studies.

Raw sewage can be utilized for irrigation of crops wherever the treatment facilities are not available. Dilution of raw sewage to bring down its biological oxygen demand (BOD) to about 150 mg/litre vis-a-vis adjustment of nitrogen application rate to meet crop requirements, and fortification of nutrients to balance the supply of N, P and K to the crop with the help of fertilizer, has proved effective in the optimization of environmentally compatible recycling of wastewaters for crop production. This technique has helped increase considerably the reuse benefits of wastewaters in terms of crop production from about Re 0.55 to Rs 1.70 per cubic metre of wastewaters. However, irrigation with untreated sewage is to be restricted only to non-edible crops, e.g. cotton, citronella, mentha, ornamentals, etc. or to those consumed exclusively after thorough cooking, e.g. cereals, pulses, oilseeds, etc.

A study of the effect of irrigation with untreated raw sewage as against diluted sewage in various ratios on soil properties has shown that the organic, inorganic and microbial load of sewage on the soil can be well distributed over a larger area by dilution with fresh water. Also, problems like soil salinity and alkalinity and sewage sickness can be effectively controlled.

Both primary-treated sewage and secondary-treated sewage, each in conjunction with supplemental NPK (mainly phosphate), through fertilizers were equally effective sources of plant nutrients for crop production [In long-term experiments, yields under irrigation with raw sewage declined after 6-7 years of continuous irrigation, whereas such an effect was not apparent with the primary-treated and secondary-treated sewage. Untreated sewage (without dilution) irrigation resulted in nutrients enrichment of the soil, which, though desirable from an agricultural point of view, led to the pollution of the ground and surface waters and hence undesirable from the point of view of the management of environmental pollution].

Field tests on a wide variety of crops under irrigation with wastewaters with varying levels of BOD (0-1000 ml/litre) have revealed that while some crops are tolerant to the high BOD wastewaters, others are somewhat sensitive. However, most of the crops seemed to grow well with the wastewaters having a BOD level of up to 150 mg/litre, which normally correspond to those of the primary-treated sewage. Irrigation with wastewater of higher BOD level also supplies much larger amounts of nutrients to the crops, which were not utilized and hence resulted in a very poor nutrient utilization efficiency. The uptake of nutrients by the crops was reduced under irrigation with wastewaters of higher BOD range.

The efficacy of integrated approach of wastewater treatment through the stabilization pond, first-stage recycling for aquaculture, and second-stage recycling with the aquaculture pond effluent for crop irrigation was also tested. The fish pond effluent irrigation seemed to require supplemental application of small quantities of fertilizers to support the optimum plant growth in agriculture. However, this approach is quite effective as a means of prevention of environmental pollution and optimum exploitation of the manurial and irrigational potential of wastewaters in aquaculture and agriculture.

Demonstrations

Field experiments carried out in the institute's campus also serve as demonstration for visitors.

A feasibility report was prepared for disposal of wastewaters for Greater Bombay by crop irrigation as a part of the consultancy project sponsored by the Municipal Corporation of Greater Bombay.

Advisory service was rendered to a few paper mills and distillery industries for recycling of their effluents for crop production.

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TOILET BLOCK FOR VILLAGE SCHOOLS

(NEERI, Nagpur)

Designed by the National Environmental Engineering Research Institute (NEERI), Nagpur, the toilet block consists of two hand-flushed water-seal pit latrines, one for boys and another for girls, and a urinal block for boys. The faeces, along with urine, flow into common soakage pit where these are digested microbially. A small water tank is provided in the urinal block so that it serves both latrines and the urinals.

The estimated cost of the latrine block is Rs 5,000 (1983).

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WASHING PLATFORMS AND SOAKAGE PITS

(NEERI, Nagpur)

The quantity of water used in rural houses by an average family is 50-60 litres a day. This requirement meets the needs of washing utensils, ablution, and for bathing of one or two persons who cannot or do not go to the source for getting it. The used water finds its way along streets and natural land-slopes and accumulates in pools, where mosquitoes breed. Large areas in the country have, therefore, been infested with both malaria and filaria germs, affecting the general health of the population.

The problem of disposing wastewater so as not to pollute the environment has been tackled satisfactorily by the National Environmental Engineering Research Institute (NEERI), Nagpur. NEERI, for example, has designed, constructed and demonstrated, in project villages, washing platforms and soak pits with silt catchers in between, to tackle the problem of sanitary disposal of domestic wastewater in rural areas. These innovations have been found extremely useful in preventing accumulation of spent water in low-lying areas and ditches, thus contributing to a clearer environment.

Waste-water disposal system

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WASTEWATER DISPOSAL SYSTEM

(CBRI, Roorkee)

Wastewater flowing over *kuchcha* (impermanent) roads is the main source of insanitation in rural areas. This breeds mosquitoes and creates nuisance. A solution to this problem has been worked out by the Central Building Research Institute (CBRI), Roorkee. This is a technique which consists of an ash-silt trap chamber divided into two compartments with triangular ducts opposite to inlet. A hole is left in the partition 11.5 cm below the top to connect the ducts. The second compartment is filled with 4 cm gauge brick ballast. The top is covered. Adjacent to this chamber, a 30 cm dia. borehole deep enough to reach the first layer of sand, subject to a maximum depth of 3 m, is made. This is also filled with brick ballast and covered. The borehole acts as a final filter before the wastewater is allowed to mix with subsoil water.

A prototype of this system built in village Rohaſki, near Roorkee, some five years ago at a cost of Rs 150 is working satisfactorily. !t was adopted by 8 households in 1979. This system has also been installed in four houses in village Khanjarpur (1980), and in six houses in village Mewad, near Roorkee (1983).

HUMAN SETTLEMENT

DEMONSTRATION OF FIRE-RETARDANCY OF TREATED AS WELL AS UNTREATED THATCH. THE TREATED THATCH HAS NOT CAUGHT FIRE.

Human Settlement

The problems of human settlement in a rural setting are no different in kind from those in an urban setting. Only it is the scale of activities in relation to rural setting that differs. The principal elements to be considered are: development of villages, their layout, planning, provision of house sites, water supply, roads, and primary sanitary and health services. The programmes for human settlement also cover: land and water management, disposal of waste, conservation of energy, pollution abatement, and judicious utilization of natural resources. All these have a direct relation with the humans staying in the villages, their living and working conditions.

Of these, housing is one of the basic needs. This has received much attention from policy makers, planners and scientists alike. The problem is challenging because of the differences in agro-climatic zones, ecology and socio-economic conditions of people. More formidable of solution is providing houses to agricultural labourers who do not have land to construct their houses. It is these factors that have been kept in view by CSIR laboratories in working out solutions to human settlement problems in rural areas. For example, the CSIR has kept in focus the need for rural construction materials, use of new substitute materials (including materials from agricultural and animal wastes) and optimum utilization of scarce materials. Also in sharp focus of the CSIR laboratories are the socio-cultural and environmental conditions of localities. Technologies have been developed, for example, for alternative design of houses for meeting the needs and expectations of low-income groups. Efforts have also been made to improve construction techniques (for example, fire-retardant thatch roof and water-repellent mud walls), maintenance practices, construction tools and equipment for enhancing work efficiency and reducing fatigue. Housing solutions have been offered for varying geographical conditions: tropical areas, hilly areas, coastal and arid zones, and other problem regions.

What is, however, needed is to provide more effective linkages between R & D infrastructure and extension services for transfer and application of these technologies in rural areas. To this end scientists have also conducted a number of demonstrations of the innovative techniques and training programmes in the field.

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ASPHALTIC CORRUGATED ROOFING SHEETS

(CBRI, Roorkee)

The Central Building Research Institute (CBRI), Roorkee, has developed technology for making a very low-cost but durable material from waste paper, asphalt and a few other materials as roofing sheets for cheap houses. Studies conducted at the institute have shown that proper control is necessary on the grade of asphalt as well as on the temperature and duration of impregnation. The sheets developed at CBRI are thicker as well as tougher than sheets commercially produced. Their better corrugation dimensions result in higher structural strength. Owing to lower asphalt content, chances of softening and flattening are reduced and there is less fire hazard. They have lower water absorption, which means better decay resistance and longer life.

Cost

The estimated cost of the sheets is Rs 9/m^2.

The plant can be located at any place in the country at an estimated cost of Rs 45 lakh. Two parties have taken the licence for manufacturing these sheets: (1) P.K. Enterprises, c/o RB Chuni Lab. and Sons, P.O. Jorhat, Assam; and (2) Eusebio E. Ferrer, Sr, General Manager, Benguet Electric Corporation, No.27 July Street, Congressional Village, Quezon City, Philippines.

Adoption of Technology

These sheets have been used for houses for tribals at Sagar and Sehore by the Madhya Pradesh Rural Engineering Services.

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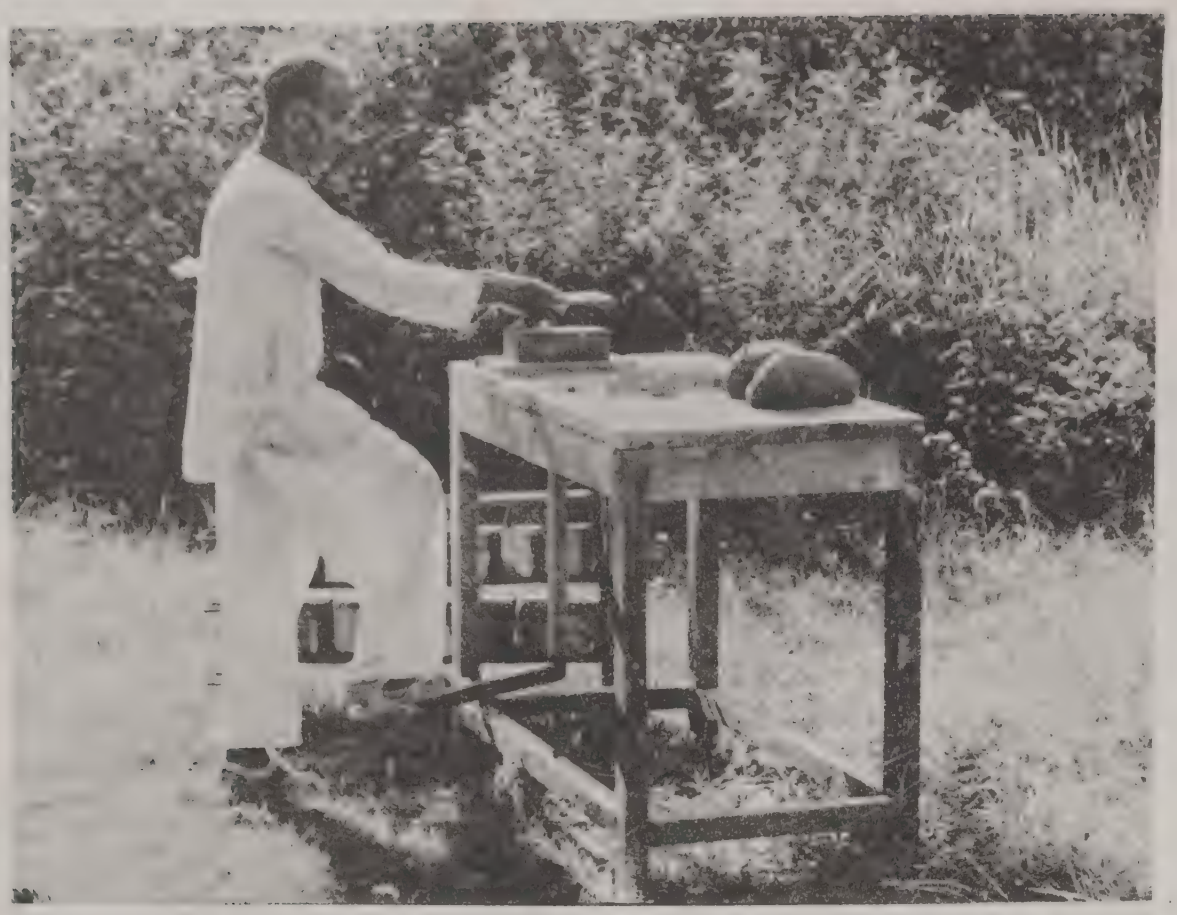
BRICK MOULDING TABLE

(CBRI, Roorkee)

Brick moulding is a skilled job and since ages it has been carried out on ground by skilled moulders. However, the traditional hereditary system of moulding is not producing moulders in numbers sufficient to keep pace with the increasing number of brick kilns. The Central Building Research Insititute (CBRI), Roorkee, has therefore designed and developed a simple table for moulding bricks which helps improve brick quality (shape and size) and which can be used by any brick moulder of average skill.

The moulding table is a wooden piece with a metallic/wooden mould fixed on it. The mould is provided with a movable mild-steel bottom plate which also carries the frog and is centrally attached to a vertical ejector shaft, actuated by a foot-operated lever mechanism.

The principal difference between the conventional practice and the new method is that in the latter the moulder does not shift his position; the prepared clay is supplied to him and the moulded bricks of improved quality with sharp edges, etc. produced are carried away for drying.



Improved brick-moulding table

The cost of the table with complete accessories like steel mould and ejector would be about Rs 450. Field trials have shown that a moulder with two helpers can mould about 1500 bricks a day.

The drawings of the moulding table have been supplied to many parties.

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BUILDING MATERIALS FROM RICE HUSK

(CBRI, Roorkee)

Rice husk, an agro-byproduct/waste, can be utilized in many ways, as for example :

(i) fuel for burning bricks, replacing coal, partially or totally, which leads to 50% economy;

(ii) admixture in brick-making: 5-10% rice husk ground and mixed with black and red soils reduced drying shrinkage and improved the strength of bricks. Mixing rice husk also resulted in 15-20% saving in fuel as it contains 8-10% unburnt carbon, which acts as fuel.

(iii) binder along with lime sludge: rice husk mixed with a small quantity of local clay and lime sludge, then fired and ground, resulted in a good binder for mortars, having 7 days' and 28 days' strengths of 35 and 80 kg/cm^2 respectively. Estimated cost of production—Rs 220/tonne of binder.

(iv) pozzolana along with clay: Experiments at Durg, M.P., in which locally available plastic clay and rice husk for making pozzolana were used, were encouraging. No additional fuel was required for firing. The product was also easy to grind. Fineness achieved was 6500 cm^2/g and lime reactivity strength of 62 kg/cm^2 as per IS: 1727-1967.

Demonstrations on rice husk clay pozzolana were conducted at five places: (1) Rice mill, near S.D.A. School, Roorkee (U.P.)—1976; (2) G.B. Pant Agriculture University, Pantnagar (U.P.)—1976; (3) Rice mill, Durg (M.P.)—1979; (4) Trimurti Industries, Cuttack (Orissa)—1981; and (5) Pozzocem Industries, Ahmedabad — the firm has made trials on the production of a cementitious binder from lime sludge and rice husk.

Adoption of Technology

(1) M.P. State Rural Engineering Department is producing cementitious binder from rice husk and clay; the department is planning to increase the production up to commercial level.
(2) Cement factories at Raipur and Durg are making use of the CBRI process for rice husk clay pozzolanic cements.
(3) The Irrigation Department, Belgaum (Karnataka), has produced rice husk clay pozzolana by adopting CBRI technique; it has used the material in some of its construction works.
(4) Trimurti Industries, Cuttack, is setting up a plant for producing pozzolana from rice husk, clay and lime sludge using CBRI technique.
(5) Other parties like L.P. Cements, Sambalpur; Sone Valley Cement Corporation, Japla (Bihar); and Akaltara Cement Works (Bilaspur) have taken up the CBRI know-how to produce rice husk clay pozzolana.

Suppliers of Equipment

(1) Kusum Engineering Ltd, 25 Swallow Lane, Calcutta 700 001
(2) Pozzolana Machinery Fabricators, P.B. 7222, Bombay 400 071
(3) International Combustion (India) Ltd, Mount Road, Nagpur.

67

CLAY TILES
(CBRI, Roorkee)

Mangalore-pattern Clay Roofing Tiles from Alluvial Clays

The necessity of developing interlocking clay roofing tiles from alluvial soils for the construction of cheap roofs in rural and hilly areas of the country on self-help basis has often been advocated. The tiles manufactured do not shape well owing to poor workability and silty nature of the soils, develop inadequate strength on firing at lower temperatures, and distort when fired at elevated temperatures. Mangalore-pattern clay roofing tiles have been developed from such soils by suitably blending plastic and clayey loams, so as to contain not less than 28% clay and 65-75% total fines. These soils on weathering, tempering and processing produce tiles of proper shape when pressed in a hand-operated screw press. The tiles dried under shade and fired in a down-draft kiln in the temperature range 820-920°C yield tiles of high transverse strength (110-190 kg) (breaking load) and low water absorption (10-12%), and show no efflorescence.

Several lakhs of such tiles based on CBRI technology are being manufactured from local alluvial soils at various production centres in Uttar Pradesh. The product is of uniform brick red colour, possessing metallic sound and good finish and conforming to IS specification for Mangalore-pattern clay roofing tiles.

Clay Flooring and Terracing Tiles

Flooring and terracing tiles are generally used in rural and low-income housing, in light-duty floors, in factories, schools and health centres and for water-proofing of reinforced brick-work or *kuchcha* roof laid over mud *phuska* or lime concrete substrata. The conventional tiles manufactured in northern India from alluvial clays show high water absorption and poor impact and abrasion resistance, while such tiles produced from plastic black and red clays in southern states are porous and possess poor flexural strength. These defects arise out of improper selection of raw materials, silty nature of clays posing poor workability, non-development of dense structure at normal temperature of firing and adoption of primitive moulding, drying and firing techniques.

Flooring tiles as specified in IS:1478-1976 and terracing tiles as specified in IS:2690-1975 have been manufactured from well-processed and weathered clayey loam as detailed below:

	Flooring Tiles	*Terracing Tiles*
Clay	25-35%	20-25%
Total fines	60-75%	50-60
Plastic index	20	18
Firing temp.	900°-950°C	900°-950°C

Tiles manufactured have been used in several schools and public and residential buildings.

Demonstrations

Demonstrations have been conducted at six centres: (1) Kumhar Udyog, Shri Gandhi Ashram, Chhutmalpur; (2) Kumhar Udyog, Shri Gandhi Ashram, Garh Road, Meerut; (3) Gramin ,aur Krishi Vikas Parishad, Powayan (Shahjahanpur); (4) H.P. Housing Board's mechanized brick and tile plant, Paonta Sahib (H.P.); (5) Centre of Science for Villages, Duttpur, Dist. Wardha (Maharashtra); and (6) Institute of Engineering and Rural Technology, Allahabad.

The first four units are manufacturing tiles based on CBRI technology.

Cost

Mangalore-pattern clay roofing tiles (Chhutmalpur/Meerut/Powayan) of effective size 320 × 210 mm	Rs 1000-1200 per 1000 Nos
Clay flooring/terracing tiles (Chhutmalpur/Meerut/Paonta Sahib) of size 250 × 250 mm	Rs 650-800 per 1000 Nos

List of Brick and Tile Machine Suppliers

1. National Alloy Steel & Engineering Products
   7/10 Botawala Building
   Horniman Circle Bombay 400 001
2. St Joseph Asylum Industrial Workshop
   P.O. Box 502
   Jeppu
   Mangalore (Karnataka)

3. Gorecha Engg. Co.
   Ravapur Road
   Morvi (Gujarat)
4. AMIC Industries Pvt.Ltd
   10 B.T. Road
   Calcutta 700 056
5. Maya Engineering Co.
   27/2 P.N. Middya Road
   Belghoria
   Calcutta 700 056
6. D.K. Engineering Works
   8 Panchantolla
   New Road
   Calcutta 700 056
7. Kusum Engineering Ltd
   25 Swallow Lane
   Calcutta 700 001
8. Janta Engineering Co.
   Chanda
   Maharashtra
9. Mookens Mills Engg. Dept.
   Poothole
   Trichur 680 004, Kerala
10. Batliboi and Co. Ltd
    P.O. Box No. 74
    26/59 Borhana Road
    Kanpur 208 001
11. Vijay Prakash Industries
    Gheruvernoor Feroke
    Dist. Calicut, Kerala
12. Mechanical Engg. Works
    Billimoria
    Gujarat

68

COIR FIBRE CORRUGATED ROOFING SHEETS

(CBRI, Roorkee)

In view of the increasing demand for roofing materials for buildings, the CBRI has developed a simple process for manufacturing corrugated roofing sheets from coir fibre, a byproduct of coconut industry (only a part of this is utilized in making mats and cushions). Unlike other cellulosic materials, coir fibre makes a strong bond with Portland cement.

For making such sheets, a weighed quantity of coir waste is first soaked in mineralized water and a requisite quantity of Portland cement is added and throughly mixed with it. The mixture is spread over the corrugated mould and pressed down hydraulically. The sheet is allowed to set for about 3 hr before shifting it to the curing shed. There, it is demoulded and kept in the shed for natural curing for a period of 7-8

Corrugated roofing sheets under production

days. It is later given a cement wash on both sides, dried, and trimmed off to the required size (2m × 1m). A water-proofing paint is finally applied on the exposed side of the sheet.

The sheets can be laid on roof-like asbestos-cement (AC) sheets. Although they require more purlins, they are about 11% cheaper than AC sheets. Besides, coir-fibre sheets possess good thermal insulation properties and could provide greater thermal comfort in tropics as compared to AC or GI sheets.

The utility of the coir roofing sheets is borne out by the fact that they were used by South Gujarat University, Surat, during 1982.

Adoption of Technology

Based on CBRI know-how, two firms have gone into commercial production: (1) Aravali Industries, E-31 Industrial Area, Abu Road 307 026; and (2) Venus Industries, 19 Perumalpatti, Pillaiyarkoil Street, Srivilliputtur 626 125.

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FERROCEMENT ROOFING UNITS

(SERC, Roorkee)

The Structural Engineering Research Centre (SERC), Roorkee has developed the following two types of ferrocement roofing units:

Ferrocement (FC) Folded Plates

Trough-shaped folded plate units of up to 5.0 m span have been developed and tested in the laboratory. The thickness of a 3.0 m span roof is only 15 mm and the units can be used for temporary as well as permanent structures. The roof does not require any maintenance. The FC folded plate is economically comparable to GI/AC sheet roof supported over standard wooden/steel structures. This does not require any bolting or site jointing. If needed, these units could be removed

and shifted to any other site without any problem. The cost of such FC roofs comes to about Rs 90/ m^2.

Segmental Shell Roof

This type of roof is assembled with precast segmental shell elements. The cost of such a roof installed at one floor level comes to about Rs 95/m^2 which is quite competitive with AC sheet roof supported over a steel structure.

Demonstration/Training

Demonstrations of both types of FC roofing units have been held, since 1978, at six exhibitions, besides at SERC, Roorkee, itself. These have testified to the soundness of the structures.

Two training courses have been organized for technical staff at the Institute of Engineering & Rural Technology Allahabad (U.P.).

The Central Public Works Department at Parliament House, New Delhi, has constructed a large cycle stand using FC segmental shell units.

The roof of a factory building of the Indian Concrete Products, Meerut, has been constructed with segmental shell units. Both the structures have further proved the soundness of the FC units.

All the materials are available in the open market.

Cost of production and erection of roof for one floor (3m) height

Ferrocement folded plate (trough-shaped up to 4.0 m clear span	—	Rs 90/m^2
Ferrocement segmental shell roofing up to 4.0 m clear span	—	Rs 95/m^2

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FIRE-PROOF ROOF THATCH

(CBRI, Roorkee)

Roof thatch easily catches fire, causing heavy losses to the villagers. The CBRI has evolved a technique of making these thatches—whether they are of paddy, cocount, reeds, or palmyrah — fire-retardant. The technique also increases the life of the thatch to almost thrice the untreated life.

The technique consists in applying the non-erodable mudplaster to both the top and bottom of thatch. If, on drying, some cracks develop in the plaster, they are sealed off with the same plaster. Over this, two coats of cow-dung slurry (*gobri*) and two coats of bitumen cutback (bitumen:kerosene:: 1:2) are applied. This is finally covered over with a coat of *gobri*.

The treatment has been successfully demonstrated at a number of places in Uttar Pradesh, Madhya Pradesh, Rajasthan, Andhra Pradesh, Madras, Maharashtra, Bihar, and West Bengal.

The Andhra Pradesh Housing Corporation, Hyderabad, under its housing project (Rs 250 million), has incorporated various CBRI

Fire-retardant thatch roof hut constructed at Devband tribal settlement near village Khodala, Mokhada taluka, Thana district.

techniques including the non-erodable mud plaster, fire-retardant and water-repellent treatment of thatch (1981).

Cost

Estimate for the treated roof works out to be Rs 25/m^2.

71

IMPROVED MUD WALLS

(CBRI, Roorkee)

Conventional-type mud walls are not very durable and therefore need frequent repairs. Such walls collapse in rains, causing losses to life and property. The Central Building Research Institute (CBRI), Roorkee, has developed sun-dried mud blocks from pond clays which can be used for walls of up to 3 m height and 23-30 cm thickness. These walls are of the same thickness from bottom to top. To make them water-resistant, a thin mud plaster mixed with fermented rice-straw cuttings and 1.0% Mobil oil is recommended.

Exposed tops of mud walls can be covered with old cotton with a topping of 2-3 cm of the plaster. As a result, rain-water penetration is warded off and the durability of mudwalls enhanced.

The technique has been recommended for the Harijan Housing Scheme to be built by U.P. Development System Corporation, Lucknow.

72

LIME KILN
(CBRI, Roorkee)

Lime is the only building material, together with probably clay and stone, that has been finding use from the dawn of civilization. Although calcination of limestone to produce lime appears to be a simple chemical reaction, the process is beset with several difficulties. It is necessary to maintain the limestone at the required temperature for a certain period, as in the absence of proper temperature control, the lime product would not be of uniform quality. It can be either overburnt or underburnt. In country-type and funnel-type *bhatties* (kilns), which are commonly used for manufacturing lime, the product is not taken out continuously but is discharged in batches. As the fire rises from the bottom to the top during the firing cycle, the out-going gases get very hot, low thermal efficiency and controls being almost non-existent in such kilns. To put the traditional lime *bhatties* on a technologically sound ground, the Central Building Research Institute (CBRI), Roorkee, undertook studies and as a result has designed and developed efficient lime kilns of varying capacity of production.

Lime kiln at KVIC unit,
Dehra Dun, U.P.

Salient Features

- The kilns are made of brick or stone masonry structures.
- The designs ensure both smooth running and periodic withdrawal of lime.
- The kilns work on natural draft and have an arrangement for its control.
- Work continuously and can also be adopted for day working only.
- Are thermally efficient, heat losses being minimum.
- Produce uniform-quality lime, with no overburning or underburning of limestone taking place.
- Can be operated by trained, unskilled labour.
- Contamination of burnt lime with fuel is minimized.

Small-capacity (about 5 tonnes/day) lime kilns cost Rs 85, 000 only and require a working capital of Rs 1,50,000. The cost of production works out to be Rs 450/tonne and the selling cost is Rs 500/tonne. The costs also depend on the place.

73

LIME-POZZOLANA CEMENT FROM RAW MATERIALS AVAILABLE IN JAMMU

(RRL, Jammu)

The development of lime-pozzolana cement owes to the historical fact that lime-pozzolana cement had been in use till the end of the nineteenth century and buildings constructed in the country with the material have withstood weathering over the years.

Of the two main ingredients of lime-pozzolana cement, lime is available in plenty in Jammu & Kashmir. As regards pozzolanas, the state has several deposits of clay around Jammu as well as at some places in the Kashmir Valley. The clay is dull white and fairly hard and occurs as compact lumps of dark grainy texture; it is also non-slaking and non-plastic.

The RRL, Jammu, has conducted extensive investigations to utilize the local raw materials to produce cement. The investigations have shown that these clays could be activated for use in cement-making. The crushing strength of clay determined in accordance with the lime reactivity tests prescribed by IS:1727 is well above stipulated strength.

Conditions for calcination of clay and its pulverization to fine powder have also been worked out.

Lime-pozzolana cement, designated as LIMSU, was produced (5 tonnes) and made available for tests in various construction activities. The results have been found quite satisfactory.

As the raw materials are available near Jammu, the transportation cost is minimal and hence the cost of LIMSU compares well with that of Portland cement. As compared to a Portland cement plant, the investment required to put up an economically viable LIMSU plant is markedly low.

74

NON-ERODABLE MUD PLASTER ON MUD WALLS

(CBRI, Roorkee)

The traditional method of application of mud plaster is cheap, but the plaster cannot withstand even a few hours of continuous rain. Owing to alternating rainfall and sunshine, the plaster ultimately comes off in flakes. It has been found that the addition of a bitumen cutback prepared with bitumen of 80/100 penetration, kerosene oil and paraffin wax to this mud plaster makes it non-erodable and water-proof.

The preparation consists in mixing bitumen and kerosene in 5:1 proportion, i.e. 53.25 kg of bitumen and 10.5 litres of kerosene, with every cubic metre of dry soil. Bitumen is warmed till it melts and is slowly added to the kerosene oil, kept in a separate container, the mixture being kept stirred till the entire bitumen is added. Wax (15 g) in a separate container is heated till it melts and stirred thoroughly. If the bitumen mix is to be used immediately, wax need not be mixed. The final coat is rendered with *gobri* (cow-dung slurry).

The estimated cost of the plaster is Rs 2.65/m^2.

The technique has been demonstrated in several places in Uttar Pradesh, Madhya Pradesh and Andhra Pradesh, Bihar and West Bengal.

Adoption of Technology

IDL Chemicals Rural Development Trust, Hyderabad, has constructed 50 huts in Gypsy village, Zahirabad (Medak Dist.), A.P., where huts were treated with non-erodable mud plaster to make them semi-permanent (1982). The Andhra Pradesh Housing Corporation has incorporated this technique in its rural housing project (1981).

75

PREFAB BRICK PANELS FOR ROOFING

(CBRI, Roorkee)

The system is based on the principle of prefabrication as applied to bricks. The reinforced roof panels are made at ground site by using 17 burnt bricks in 1:4 cement-coarse sand-mortar or 16 burnt bricks in 1 : 2 : 4 cement concrete reinforced with 2 mild steel bars of 6 mm. The first is applicable to good-quality bricks with a crushing strength of 70 kg/cm^2 or more. The size of the panel is 560 × 1040 mm. These panels are supported on partially precast RCC joists and joined together in 1 : 4 cement-sand mortar. Reinforcement with 6 mm dia. bar, one on each panel both ways, is also provided. Over the panel slabs, a 30 cm thick cement concrete of grade M 150 is laid all over the roof. This is topped with a water-proofing layer.

The system offers considerable saving in bricks (30-35%) as against 115 mm thick RB roof slabs. The unreinforced prefabricated brick panels can be used for walls also, in which case there is a reduction of about 60-70% bricks in walls as against a one-brick-thick wall. The thermal requirements of walls are met by providing a layer of a sun-dried brick wall of 75 mm thickness on the inner face.

Adoption of Technology

The system has been widely adopted for construction of houses for landless labourers, Harijans and economically weaker sections of society (EWS) as indicated below:

1. 40 houses for Harijans in U.P. (1972-73)
2. 1,550 houses for EWS by Ghaziabad Development Authority (1974)
3. 2 houses for CBRI employees under Special Loan Scheme (1975)
4. 1,800 EWS houses by Ghaziabad Development Authority (1976-77)
5. 50 houses for refugees at Hastinapur, Meerut (1976)
6. 52 houses for jawans by BEG and C, Roorkee (1976)
7. 200 houses for EWS by Gujarat Housing Board, Ahmedabad (1977)
8. 200 houses for EWS by U.P. Housing Board, Lucknow (1977)
9. 240 houses for Harijans in Dist. Ghazipur by R.E.S. Dept. of U.P. (1977)
10. Harijan houses in U.P. by Harijan Evam Nirbal Varg Avas Nigam Limited, Lucknow (1976-78)
11. 300 houses by Kerala Housing Board (1978)
12. 200 EWS houses at Bhopal under HUDCO scheme by M.P. Housing Board (1978)
13. 100 Balvadis in M.P. by Rural Engineering Department, Bhopal (1980-81)
14. 180 EWS houses by Ghaziabad Development Authority (1979)
15. houses at Government Polytechnic for Women at Madurai by Technical Education Department, Madras (1980)
16. a hostel at Annamalai University and a garage block at Engineering College, Karaikudi, by Education Department, Madras (1980)
17. 600 houses at Neyveli for Sri Lanka repartriates by Tamil Nadu Harijan Development Corporation, Billupuram (1980)
18. 2,100 EWS houses by NOIDA (1980-81)
19. 27,000 houses for landless rural poor, Punjab
20. 4,000 houses for Harijans and rural poor, Haryana
21. a verandah for a temple and a gurudwara, BEG and C, Roorkee
22. a mosque at the village Baheri, near Roorkee
23. 20 Harijan houses at the village Sunehra, near Roorkee
24. 20 Harijan houses at the village Rohalki, near Roorkee
25. 10 houses at the village Norway, District Muzaffarnagar (1983).

76

RICE HUSK AS FUEL FOR BRICK KILNS

(CBRI, Roorkee)

The brick industry needs about 9.6 million tonnes of coal every year for firing bricks in kilns. The demand for coal is not fully met by railways and more than half of the quantity is transported by road. As a result, the cost of coal increases. In order to meet this situation, CBRI studied many alternative fuels and found rice husk as a most viable fuel. The technology could, however, be used in places where coal is not available but where rice husk is abundantly available nearby.

The calorific value of rice husk is 2800 kca1/kg, which is about 40% of the calorific value of grade I coal (7150 kcal/kg). Hence, this agricultural waste can meet, to some extent, the demand for coal energy-wise. The CBRI has, therefore, developed a technique for burning rice husk in

brick kilns so designed as to use this as fuel. The process is simple and can be easily adopted by kiln owners in their conventional kilns.

Demonstration trials have been conducted at three places: (1) near Roorkee on a small scale (1979-80); (2) at Rampur Maniharan, Saharanpur Dist.—Rice husk along with firewood used in a Bull's trench kiln for total substitution of coal; and (3) at Sitarganj, Dist. Nainital, (1979)—Rice husk used along with coal in a Bull's trench kiln for 40% substitution of coal.

77

RURAL HEALTH CENTRE BUILDING

(CBRI, Roorkee)

Health facilities are indispensable for building up a strong human resource. An integrated pattern has, therefore, been evolved for extending health services in rural areas through the establishment of Primary Health Centres (PHC), each catering to a population of 80,000 to 1,00,000. When in need of specialized facilities, these centres will draw upon the resources of a district hospital. PHCs will be required to govern and control smaller units or sub-centres which are planned to serve a population of 8,000 to 10,000 each at village level. Each PHC will be responsible for the smooth functioning of 8 to 10 sub-centres.

The enormous growth of population, a major deterrent to all developmental efforts, also needs to be checked by dispensing family planning facilities throughout the country. Hence, a large number of Family Welfare Centres (FWC) are being provided in rural and urban areas. It is also envisaged to provide sufficient facilities for maternity and child health-care, and for training medical personnel. In addition, administrative support, dispensing and laboratory facilities, and residential accommodation for various grades of medical staff are also being included. The programme, in content and scale, underlines the need for research on health buildings to enable designing of efficient and economical buildings within the limited resources available. The CBRI, therefore, undertook studies on planning and designing of

Rural health-care centre building at Shahpur Muzaffarnagar dist. (U.P.)

primary health centres and sub-centres keeping in view the space standards and design guidelines for implementation of the project at the national level.

Researchers kept in view the following types of buildings:sub-centre, rural family planning centre, maternity sterilization wing at PHC, hospital for field trainees, auxiliary midwife training centre, district bureau, maternity sterilization unit at district hospital, urban family welfare planning centre, and urban maternity home.

The studies encompassed such factors as furniture and equipment, movement patterns, anthropometric data, environmental conditions, and other design parameters including space norms. A major programme of constructing several hundred health buildings utilizing the research findings was completed in rural areas of Uttar Pradesh and Karnataka (covering a population of 19.3 million) under the India Population Project. The CBRI-based construction techniques effected about 20% economy.

78

RURAL SCHOOL BUILDING

(CBRI, Roorkee)

Because of the rapid growth and expansion of primary education in rural areas, there is an urgent demand for a large number of school buildings. The increase in the school-going population also requires large-scale construction of school buildings. Financial resources being meagre, economy in the cost of construction of rural school building is of great importance, especially to help the education programme to catch up speedily.

CBRI took up research on school buildings with the object of providing design data on functional and physical requirements and for studying methods of cost reduction in planning and construction techniques. The programme has shown promising results in the rational use of space, analysis of costs, improved construction and design techniques, and major use of locally available materials and labour.

Primary school building in the village Mandarar near Bhagwanpur, Muzaffarnagar dist. (U.P.)

The CBRI design of these schools uses prefabrication for roofing, and, in some cases, for foundations and columns supporting the roof. With this system of construction, it has been possible to complete a school on site in as short a time as three weeks. It is seldom that building research has been applied on such a large scale in such a short time.

In the final stage, the school consists of four class-rooms, a sheltered space, the headmaster's room, space for cooking mid-day meals, and a hygienic urinal, with well-landscaped and developed school site. Each class-room has been designed to provide space for 40 children and to provide adequate space for black boards, storage and display. Proper lighting and ventilation has been taken care of. Built-in cupboards have been provided. The cupboards also enable the village teacher to use them as wardrobe for his overnight stay in the school.

The construction scheme consists of RCC prefabricated footings, columns, doors and window frames, 'chhajjas' lintels and roofing units. The roofing units are both for flat and for pitched roofs. The scheme has been developed after considering the volume and type of skilled labour available in rural areas. Important features of the scheme are: (i) minimum number of standard components are used; (ii) simplified casting methods; (iii) minimizing the use of skilled labour; (iv) light-weight individual components which can be handled by manual labour; and (v) simplified joint details and erection methods. The scheme provides a skel ton structure first. Walls, windows and doors can be added later with locally available materials. This also encourages community participation by way of labour and materials.

Besides catering to the social needs of providing a maximum number of primary school buildings with the limited financial resources, the project offers employment not only to engineers and technicians but also to unskilled village labour.

About 2,400 primary school buildings have been constructed in the rural areas of 30 districts in U.P. and about 500 school buildings have been put up in Manipur and Nagaland in the North-Eastern Region.

79

SOLAR TIMBER-SEASONING KILN

(CBRI, Roorkee)

Large quantities of timber are required in buildings and although about 400 species of wood are available in the country's forests, only seven or eight species are generally used. Since the building construction activity is growing phenomenally and the trend will continue, the need to use other species of wood also becomes manifest. One of the most important measures needed especially when inferior timbers are to be used is to season the timber properly. This is because timbers generally warp, crack, shrink or swell during use. A solution to this problem is available from the Central Building Research Institute (CBRI), Roorkee, which has designed and developed a low-cost, quick and simple timber-seasoning method using solar energy.

The kiln consists of three main parts: a solar energy collector, a drying chamber, and a chimney. For the solar energy collector, a black-painted galvanized-iron sheet is used. A double-walled chamber is made with a transparent glass except for the north wall which is of brick masonry.

Solar timber-seasoning kiln installed at Har dwar (U.P.)

Black-painted aluminium fins are fitted in the south wall at an angle of 30^0 with the horizon. The roof is made of black-painted corrugated galvanized-iron sheets and has a slope of 1:3. A chimney is fitted vertically in one of the corners of the roof to provide stack effect. The kiln is designed in two capacities of seasoning — $3m^3$ and $15\ m^3$ of wood. The cost of construction of the smaller kiln is about Rs 15,000, while that of the bigger one is about Rs 40,000.

The kiln seasons timber to 10% moisture content within a reasonable time, i.e. in about half the time required in air-seasoning. No operational costs are involved as the natural draft eliminates the use of electric power for driving out the moisture.

The cost of seasoning a cubic metre of wood in the solar kiln would be about Rs 150 as against Rs 350 in a steam-heated kiln.

The technology has been adopted by three parties: (1) Intop Seasoners, E-28 Industrial Area, Hardwar; (2) West Bengal Forest Development Corporation Ltd, Siliguri; and (3) Department of Industries, Government of Arunachal Pradesh, New Itanagar.

80

STABILIZED MUD BRICKS

(CBRI, Roorkee)

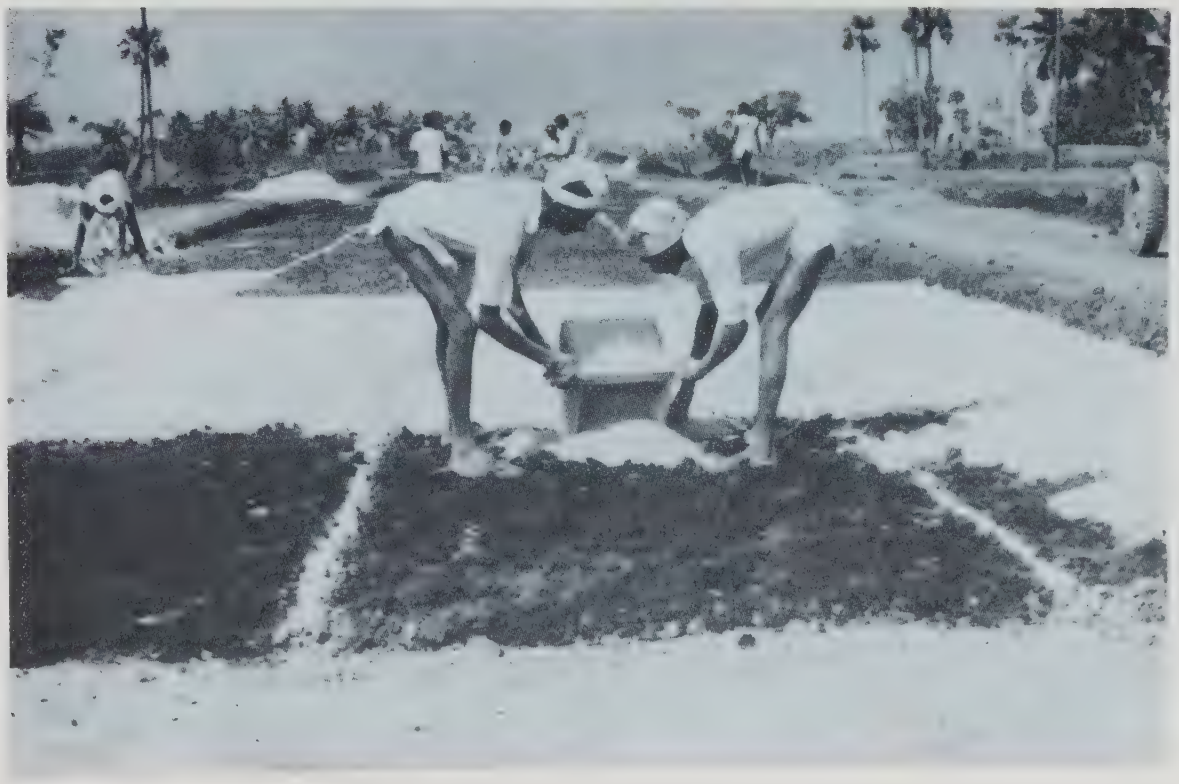
Sun-dried mud bricks used for house construction in rural areas have poor strength and are subjected to erosion in rainy season. Such houses, therefore, need repair and reconstruction every year. Researches at CBRI have shown that different stabilizing materials like Portland cement, industrial wastes like sugar press mud, lime, bitumen, etc. added to soil can improve the quality of bricks in varying degrees. Cement-stabilized bricks have good strength, but have poor moisture

resistance. Bitumen-stabilized bricks, on the other hand, are not as good in strength but are better in moisture resistance.

Bitumen-stabilized bricks have been used in 18 demonstration rural houses at village Manimajra, Chandigarh. Lime-stabilized flooring has been used in 10 demonstrations in rural houses at village Bankaner (near Delhi), in 10 houses in Pondicherry, and in 20 houses in Dharmapuri (Tamil Nadu).

ROADS AND COMMUNICATION

VILLAGERS MAKING A RURAL ROAD WITH LOCAL MATERIALS



Roads and Communication

Roads are the life-line to prosperity of the rural community as they are not only the means for communication and transport, but also ensure easy and quick delivery of goods and marketing services of farm and dairy products. They generate more work opportunity for people staying in these areas. 'Rural road' means the all-weather road and related constructions like streets, pavements, and water crossing/ culverts constructed in plains as well as hilly, coastal, desert and flood-affected areas in rural and backward regions. In the construction of rural roads, a multitude of factors comes into play. These include: utilization of local raw materials (in road construction), nature of vehicular traffic especially the bullock-carts, local conditions of rainfall, nature of land, water-logging, etc.

All these need an in-depth study of soil strata, survey and planning, of nature of construction material available locally, and the technology of their conversion into materials appropriate for road construction. This also involves a study of special locational problems like desert, rainfall, recurring floods, soil erosion, etc.

CSIR through its CRRI has contributed in substantial measure to the provision of such roads.

Rural roads need to be developed in stages. The technology for construction and maintenance should be simple enough to be adopted by the rural people themselves with the help of local manpower and animal power.

Quite apart from the traditional road communication, CSIR laboratories are also concerned with providing modern telephone and telecommunication facilities to the countryside. While radio and television services provide, as they are, only one-way 'messages', one of the CSIR laboratories has also a simpler solution, in the form of rural communication system, to send messages within a radius of 50 km. These and such other community needs have been studied by the scientists and their work in this direction is presented here.

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FERROCEMENT IRRIGATION/ DRAINAGE CHANNEL

(SERC, Roorkee)

Semi-circular and trough-shaped ferrocement irrigation/drainage channel units have been developed by the Structural Engineering Research Centre (SERC), Roorkee. The channel unit has a built-in collar at one end for jointing and laying irrigation/drainage lines at a fast rate. A process for casting these units has also been developed. In this, a masonry mould which fits exactly in the inner surface of the channel unit is cast, the mortar being subjected to vibration and compaction with a device made of mild-steel frame and a medium-frequency vibrator.

The reinforcement cage for the channel unit, which is made of steel wires and wire meshes, is placed over the oiled masonry mould over which a layer of an old newspaper sheet is spread. A rich cement-sand mortar (1:2) is applied over the reinforcement cage and compacted with the vibration-cum-compaction device, which also shapes the unit to a uniform shape.

The channel units are lighter than RCC water channels of semi-circular shape, are cheaper than 9 m brick-work irrigation/drainage channels, and could be repaired easily if accidentally damaged. If electricity is not available, the units could also be cast by hand application of mortar.

A demonstration was held at SERC, Roorkee, in 1980.

Training courses were organized at SERC, Roorkee, in 1979 and at the Institute of Engineering and Rural Technology, Allahabad, in 1981.

For casting a 30 cm dia. semi-circular unit it costs Rs 25 per running metre.

Ferrocement irrigation and drainage units

Planning

In view of the vast network of rural roads required to be developed during the next few years, it has become imperative to prepare master plans at the district/block level to connect through roads all villages, irrespective of their population, to the nearest market centre or service centre or main road. In the absence of master plans, the development of rural roads could be haphazard and lead to a considerable amount of avoidable expenditure. Realizing the importance of such master plans, the Central Road Research Institute (CRRI), New Delhi, has developed a simple model for systematizing road development activities in rural areas. This model is based on the principles of systems engineering, the only parameters involved being the population of the village being connected and its distances from the adjoining villages and the market/service centre/main road. A step-wise procedure has been set forth for providing only one road outlet to each village.

Pavement design

Recognizing that the type and volume of the traffic in our rural areas and the minimum requirements of acceptable serviceability are quite different from those in urban areas, or rural areas in the developed part of the world, CRRI considered it necessary to develop appropriate pavement design strategies which are relevant to the Indian conditions. The pavement-design methodology proposed by CRRI for rural roads involves the concepts of a composite 'traffic index' (incorporating the solid-wheeled carts in addition to the pneumatic-tyred commercial vehicles and other light vehicles like tractor-trolleys and tempos) and the 'strength index' for evaluating the strength of the subgrade (compacted local soil) under given climatic and groundwater conditions. Two sets of pavement-design curves for rural roads have been developed by CRRI based on the minimum levels of serviceability considered acceptable in rural areas.

Paving materials

In regard to the materials that go to compose a rural road pavement, emphasis has been laid on the use of locally available materials to the extent possible. Such local materials include gravels/moorums, sands and soft aggregates (like laterite, *kankar,* and brick ballast). Besides the technique of mechanical stabilization, i.e. blending of local soil with locally available sands, gravels/moorums and aggregates, the technique of soil stabilization with lime, particularly for highly clayey soils (like black-cotton soils), has also been recommended. On the use of locally available materials and reduced pavement thickness requirements the CRRI's experience gained through the construction and performance evaluation of a large number of rural road experimental lengths and test tracks in different parts of the country has shown convincingly that the recommended techniques are effective. It has also been found that economics of the order of 20-25% in comparison to the conventional construction costs could be effected by adopting the CRRI techniques.

Construction technologies

During the construction of rural roads, experience shows that to obtain the desired degree of compaction, the conventionally used

power-driven road rollers and water bowsers are not always available in rural areas. In the absence of such power-driven compaction equipment, alternatives have been suggested by CRRI by way of tractor towed/animal-drawn road rollers/water bowsers. In addition, a new set of site quality control procedures requiring only very simple testing equipment and appropriately reduced acceptance criteria has also been set forth for rural road construction. Similarly, the possibility of using empty oil/bitumen drums to form a flexible conduit for low-cost culverts for rural roads with very low traffic volumes has been explored.

Rural road construction and maintenance hold considerable potential for rural employment. The soil stabilization techniques of construction recommended by CRRI for rural roads have a higher labour component of the total construction cost in comparison to the conventional techniques of stone soling and water-bound macadam construction. Because of the non-availability of needed data, CRRI undertook an extensive study of 285 sections of 175 rural roads spread over nine states of the country.

Demonstrations

Besides about 35 experimental road lengths constructed with the soil stabilization techniques during the last about 25 years, specially designed rural road test tracks with the more recently evolved techniques have been laid and their periodic performances evaluated. The latter are: (1) Naiyana-Taheb Road, near Anantnag (J&K)-1976; (2) Siligaum-Kishangam Road, near Pahalgam (J&K)-1976; (3) K.B. Road to Ulchala, Kurnool Dist. (A.P.)-1977; (4) Kekri-Baghera Road, near Kekri (Ajmer, Rajasthan)-1978-79; (5) Lachhadsar-Momasar Road, Churu Dist. (Rajasthan)-1978-79; (6) Bijapur-Ukkali Road (Karnataka)-1980; (7) Athanga-Naharbhanga Road, near Cuttack (Orissa)-1981; and (8) Aladu-Manopuram-Somanjari Road, near Madras (Tamil Nadu)-1982.

Training Workshops

Four training workshops have been organized at: (1) PWD (B&R), Tripura-1979; (2) Zilla Parishad, Karimnagar (A.P.)-1979; (3) Panchayati Raj Engineering Department (A.P.) Hyderabad-1983; and (4) PWD (NH and Projects), Cuttack (Orissa)-1983.

In addition, CRRI has played a key role in organizing four Indian Roads Congress regional workshops, one each in the northern, western, eastern and southern zones at Naini Tal, Gandhinagar, Ranchi and Hyderabad respectively during 1981-82, for appraising regional aspects and updating road practices.

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RURAL WIRELESS COMMUNICATION

(CEERI, Pilani)

To improve communication in villages the Central Electronics Engineering Research Institute (CEERI), Pilani, has developed a rural wireless communication (RWC) system. It uses 4W, 2W, 1W and 500 MW transreceivers and passive and active antennas. In the 27 MHz band, the Ministry of Communications of the Government of India has allocated three channels (27.065 MHz, 27.105 MHz and 27.125 MHz) for the RWC

experiment. An initial experiment was conducted for three villages (Jherli, Dandhar and Khedla) with CEERI-Pilani as the station. The system can be planned for any rural area with a radial coverage of about 15 km from the central station. This communication system can be used for transmitting and receiving messages from villages to control station or vice versa and to provide a follow-up action. The system finds use, for example, in case of: (i) local shedding of power supplies in the villages; (ii) major breakdown of tractors and pumping sets; (iii) early warning of strong winds and locusts; and (iv) health emergencies for humans and animals.

The transmitter part of the transreceiver can be operated from suitable solar panels available indigenously from the Central Electronics Ltd, Sahibabad.

The system has also found applications for communication from sugar factories to surrounding farms, and for surface and underground mine communication.

The cost of transreceivers is about Rs 3000 each (excluding the cost of solar panels).

Demonstrations have been conducted in three villages around Pilani, and at Simbhaoli Sugar Factory, U.P.; Bharat Coking Coal Ltd, Dhanbad (aerial ropeways); and Khetri Copper Mines (surface-to-cage communication).

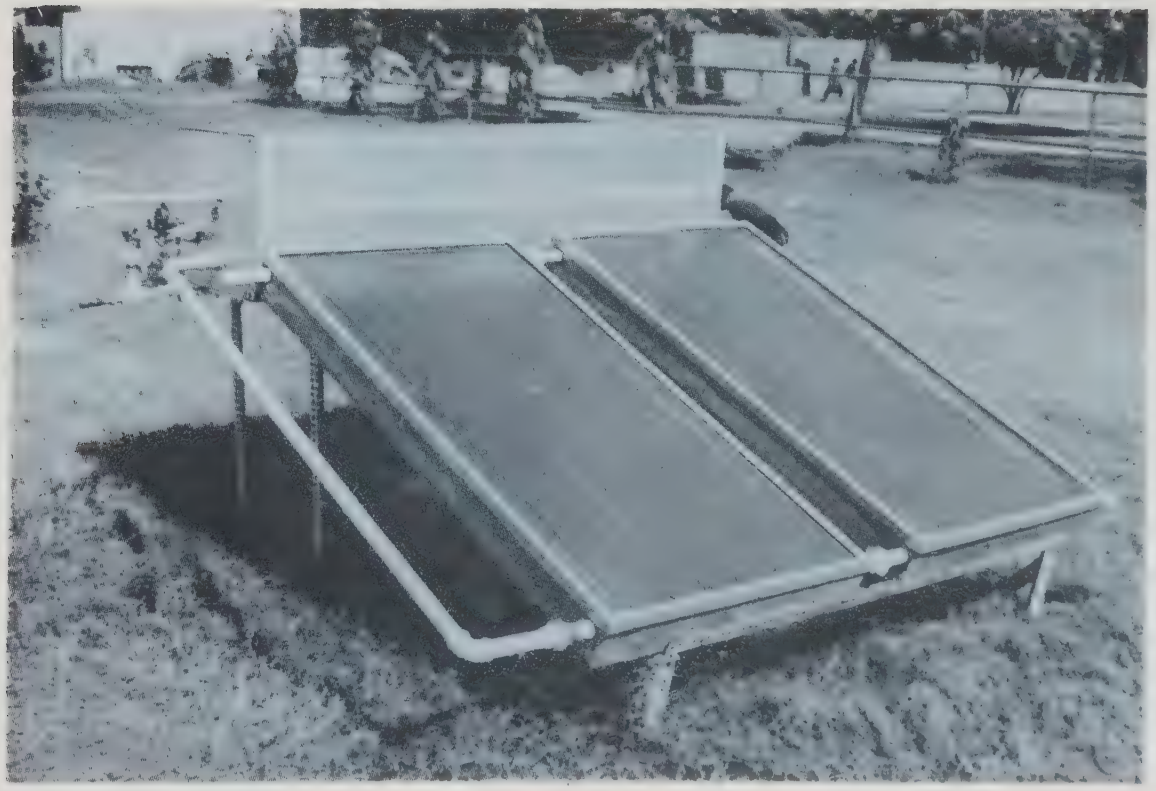
Adoption of Technology

Seven transreceiver units have so far been supplied to three user organizations: Punjab Wireless Systems, S.A.S. Nagar, Mohali, Punjab; Simbhaoli Sugar Factory; and Khetri Copper Mines.

A rural communication system working on solar cells

ENERGY

SOLAR WATER-HEATER SYSTEMS (NPL DESIGN)



Energy

While the rural population as a whole is poorer than even the economically backward urban class, the bulk of the rural class itself is even poorer. They have to undergo hardships to procure fuel for cooking. The rural communities' energy needs, besides for cooking, are for lighting, water-lifting, pumping, drying of grains, cottage industry, water purification, desalination, etc. It is in this context that the concept of harnessing alternative sources of energy in rural areas has been receiving great attention by planners and researchers alike in recent years. R & D efforts have, therefore, been directed to exploring the potential of using solar energy, wind power, biogas, etc. Also receiving attention are the use of enormous farm-waste for efficient energy-production and role of various energy plantations (social forestry) in solution to the energy problem.

In rural development, 'energy' relates to optimally harnessing local resources with the use of suitable devices matched to local needs, pattern and energy sources as well as to the cultural and social habits of the people. Some of the appropriate solutions which CSIR laboratories have offered are: improved firewood stove (*chulah*), solar cooker, solar drier, solar dehydration units, windmills, and biogas plants. The biogas plant has been found most appropriate in rural areas as it enables the multiple and efficient use of organic waste materials like animal dung, human excreta, vegetable waste, water hyacinth, etc. and produces fuel in the form of gas, simultaneously with high-quality manure. It is comparatively a low-capital-intensive technology.

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FLAT-PLATE COLLECTOR
(NPL, New Delhi)

A number of flat-plate collectors of different designs and materials have been developed by the National Physical Laboratory (NPL), New Delhi. Under Indian conditions, two collectors, one with a copper tube and an aluminium sheet, and another with a copper tube and a copper sheet absorber were found most suitable. The know-how for these collectors has been passed on to NRDC for commercial exploitation.

A flat-plate collector consists basically of a tube and a sheet absorber coated with a black paint and kept in an insulated box. The box is sealed with a glass sheet on the top. Water enters the collector through a header tube and passes through the riser tube and comes out from another header tube. Normally, 50 litres of water can be heated to 60°C on a bright sunny day using 1m² area of the flat-plate collector. It is, however, possible to heat the water to even 85°C using a flat-plate collector with selectively coated absorber. These falt-plate collectors are available in the market at a cost of Rs 1500-2000/m² area. The collectors could meet the hot-water needs in cottage industries in the areas of dyeing, bleaching and laundering; they could also find domestic uses.

Flat-plate air collectors have also been developed at NPL. These collectors are capable of giving hot air at temperatures of 45-55°C. Air collectors could be used in drying, demoisturizing, dry-cleaning, wood-seasoning, and space-heating in winter.

A sophisticated facility for testing the instantaneous and comparative efficiencies of a collector has been set up at NPL.

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PORTABLE SOLAR COOKER
(CMERI, Durgapur)

A novel solar cooking unit developed by the Central Mechanical Engineering Research Institute (CMERI), Durgapur, has characteristics which are distinctly superior to those of other solar cookers developed and marketed in the country. The CMERI cooker consists of a collapsible, curved reflector (of about a metre diameter) mounted on a tripod light-weight stand. The reflector concentrates sun rays for cooking in a specially designed two-chamber pot. The stand can be manoeuvered to track the sun with manual effort. The total height of the unit is about 1.5 m. The components of the unit are detachable and can be kept in a small kitchen.

The cooker is suitable for small families for regular as well as occasional use, as in camping. The gadget takes less than 1½ hr for cooking food in winter, and much less in summer.

The cooker together with the cooking pot and the carrying case costs about Rs 400.

Demonstrations

In the institute's campus itself more than 20 demonstrations have been held. Elsewhere, two demonstrations have been held at: Solar Devices Conference at BITM, Calcutta (October 1983); and Indian Journalists' Association Exhibition, Durgapur (November 1983).

The reflector material, manufactured by the Indian Aluminium Company, is available in the market.

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SOLAR COOKERS

(NPL New Delhi)

One of the pioneer institutions in the country to realize the importance of solar energy, the National Physical Laboratory (NPL) initiated work as early as 1950's when the first solar cooker model (paraboloidal aluminium) was developed and know-how transferred to Devidayal, Bombay. Since the energy crisis was non-existent then, and also because of several other reasons, the cooker did not attract the attention of prospective users. However, in the wake of the energy crisis in 1973, the CSIR reviewed the prospects of solar energy utilization in India with the result that NPL resumed work in this field in 1974. Because the solar collector is the heart of all solar thermal devices, NPL has laid emphasis on the development, fabrication and testing of flat-plate and concentrating solar collectors.

This CSIR laboratory has developed three different models of solar cooker for cooking rice, pulses, and vegetables.

Model 1

This is an improved version of the 50's model. It has a paraboloidal glass silvered at the rear side with a protective coating over the silvered side. This has not only improved the life of the reflecting surface, but increased its efficiency. The laboratory-model cooker costs Rs 1000.

Model 2

Since the fabrication of the earlier model posed fabrication problems, another model with a plane booster mirror has been fabricated. This model is provided with an octagonal arrangement of booster mirrors to enhance concentration ratio and temperature up to 250°C. The laboratory model of this cooker costs Rs 1500.

Model 3

This is a hot-box-type cooker with a single booster mirror. It is undergoing efficiency trials. The model costs only Rs 500.

A *chapati* being made on a solar cooker →

SOLAR DRIER

(NPL, New Delhi)

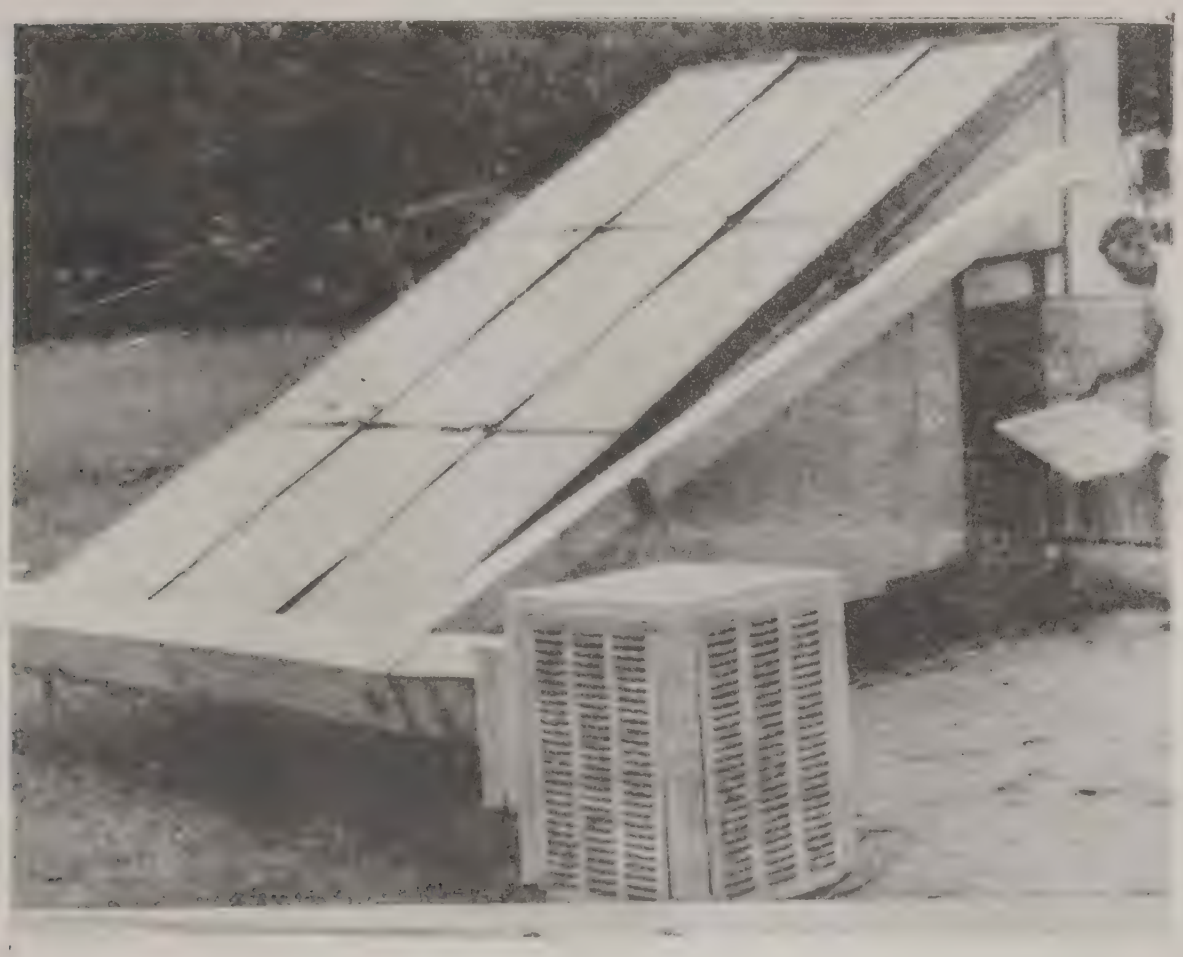
Solar drying has found application from time immemorial for drying agri-horticultural produce such as grains, fruits and vegetables. This open sun-drying method, however, suffers from drawbacks, viz. it is unhygienic, relatively slow, vulnerable to the vagaries of weather, etc. A solution to this problem is to provide controlled atmospheric drying with a solar drier.

A typical solar drier consisting of $12m^2$ area of air collectors and capable of drying 100 kg of corn per day has been designed and fabricated. In this drier, air is blown from a blower through the collectors. The hot air then enters the drying chamber and takes away moisture from the corn. This air can be recirculated through the collector till it finally gets saturated with moisture. At this stage, fresh air is introduced into the collectors. This process continues till the corn dries completely. The drier can also be used for drying various vegetable produce such as potato chips and onion.

The NPL's solar drier has been demonstrated at many national and international exhibitions.

The cost of the drier depends upon its capacity and the nature of material to be dried. The cost of a 100 kg capacity drier (mentioned above) is estimated at Rs 9000. All the components needed for fabricating the drier are available locally.

A solar drier catering to the needs of a laundry in Delhi has also been designed and fabricated. This drier is capable of drying about 400 clothes in an hour.



A solar drier model; the material to be dried is seen in the tray.

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SOLAR DRIER
(RRL, Jammu)

Sun-drying is perhaps the oldest method of food preservation. It is still practised in the same manner as in ancient times. Sun-drying, however, has several drawbacks: it is slow, requires huge areas, and produces non-uniformly-dried products. Moreover, prolonged exposure of the harvested crop to atmosphere leads to contamination with dirt and dust, insect infestation, occasional drenching with dew or rain, general decay, and quality degradation.

Marketing requirements and the desired quality attributes demand a quicker and hygienic method of drying spices, fruits and vegetables. Solar dehydration, which combines sun-drying with temperature control and regulation of air flow, not only improves the quality of the sun-dried product but also increases the drying efficiency. Solar driers developed by the Regional Research Laboratory (RRL), Jammu, are a real boon to farmers in remote villages where electricity and other forms of energy are not readily available. The driers maintain a 25-30°C higher temperature above the ambient temperature and also offer better hygienic conditions. In the drying of apricots and chillies, the drier reduces the drying time to just 3-4 days and yields a wholesome product of better appearance and taste and of longer shelf-life.

The RRL has designed and developed two types of solar drier for drying chillies, fruits, vegetables and other agro-based products.

One of the driers is based on natural air circulation and has a solar heat trapping area of $4m^2$. This drier has been fabricated with galvanized-iron corrugated sheets to provide more surface area and blackend with a special black paint, the top being covered with 4 mm thick glass panes. This is the heat-trapping area called solar collector. Inside this, suitable trays made out of wiremesh and painted with a black paint are kept. These drying trays are kept in such a way that a minimum shadow is cast on the heat-absorbing area. Two dampers are provided at the back of the drier for the control of air circulation and temperature. This type of drier gives a temperature rise of 30 to 35°C above the ambient temperature. A drier with a drying capacity of about 25 kg of raw chillies has been fabricated and installed at Panchari, Udhampur Dist.

The other type of solar drier is based on induced draft. The salient features of the drier are that it is fabricated out of aluminium sheets and fitted with corrugated aluminium foil to provide more heating area and better heat transfer. The corrugated foil, which acts as fins, is painted with a special black paint and the whole structure is housed in a wooden frame to give strength and act as an insulator. The top is fitted with 4 mm thick glass panes and is connected to a separate drying zone. The drying zone, or the drying chamber, is made out of wood and fitted with glass panes on three sides and also on the top, while the fourth side is provided with fixed racks over which wiremesh trays are kept. These trays are filled with the material to be dried. On the top of the drying chamber is a chimney of suitable height. This creates a draft in the chamber, which in turn sucks hot air from the collector and becomes a continuous source of heating and drying.

This type of drier has been fabricated and installed at Dharmari (Udhampur dist.), where it was demonstrated to a huge gathering of rural people.

A demonstration of solar drier, including training for operating the drier, was organized at Doda (September-October 1980) for drying of *anardana* (seeds of a sour variety of *Punica granatum*). The dried produce was found to be much superior to the traditionally dried material and fetched a 50% higher price.

Chillies being dried in a solar drier, made of mud, in Kashmir Valley

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SOLAR DRIER —CABINET-TYPE

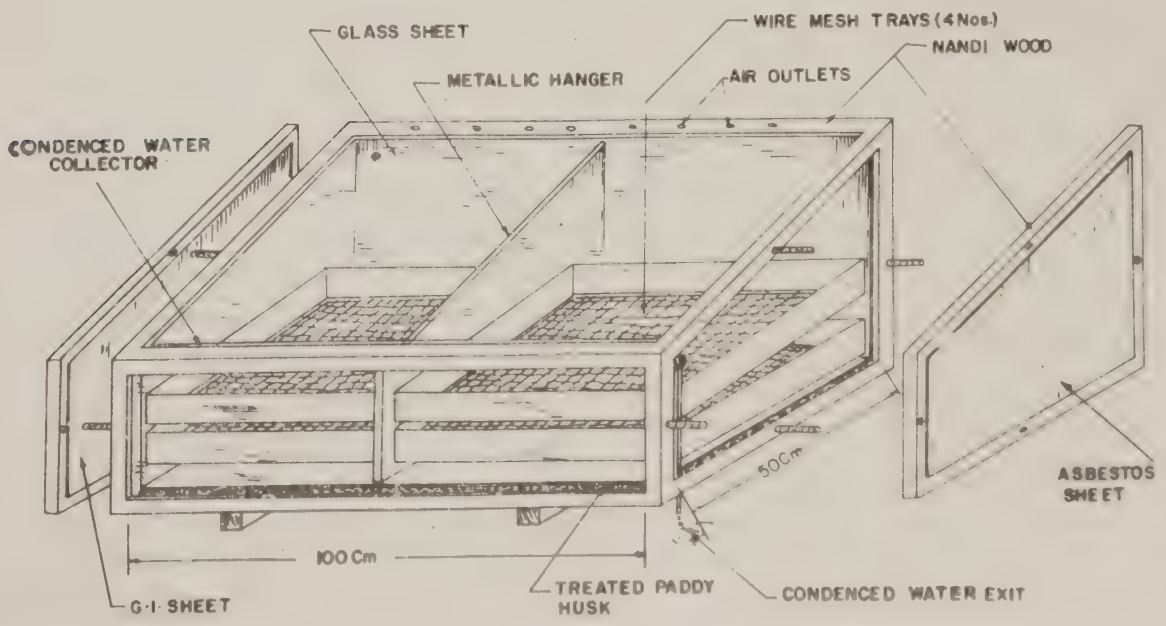
(NIO, Goa)

Sun-drying of marine and farm products, when harvested in plenty during peak seasons, is the cheapest and the oldest method of food preservation. However, it has some drawbacks. It is time-consuming and generally needs considerable manual labour. It is also not possible to achieve complete drying, and the product, because of its high moisture content, is prone to attack by bacteria and fungi. By passing air over a blackend flat-plate solar collector, it is possible to raise air temperature substantially. Based on this simple principle, the National Institute of Oceanography (NIO), Goa, has developed a cabinet-type solar drier.

The solar drier consists of a rectangular box, of 100 × 50 × 35 cm dimensions, with an inclined upper lid. The drier (weight, about 50 kg; floor space, 0.5 m^2) has two special features: (i) a nylon wick to collect and discharge condensed water, and (ii) a detachable metallic hanger fitted in the middle of the cabinet to increase the drier efficiency. The hanger is made of a galvanized-iron sheet and matallic shavings — waste from lathe shops. The hanger quickens the drying rate by about 10%.

Experiments have shown that about 50 large-size coconuts cut into halves can be dried in one lot in about 48 hr. The temperature of the *in-situ* air in the laden state (coconuts), it was found in an experiment, to be about 70°C in May (1980), whereas in the unladen state it was 95°C. An open-air drying trial conducted simultaneously showed that it takes about 9 days to dry coconuts. Red chillies and grapes could be dried in about 72 hr. The metallic hanger was necessary only in the initial phase of drying.

To operate it the drier is kept in an open space with its longitudinal axis in the east-west direction, the tilted cover facing the south. The material to be dried is loosely spread over the four trays provided for this purpose. The side doors are now closed. Once every morning the drier is opened, the material remixed, and the position of the trays interchanged. The degree of dehydration required can be standardized for every product to be dried on the basis of previous experience or by a few initial trials.



Schematic diagram of solar drier for drying marine-cum-farm produce

An important feature of this design is that its components can be easily dismantled, packed and reassembled. Its design being simple the drier can be fabricated by semi-skilled workers of rural areas after a short training.

The estimated cost of a prototype unit is Rs 500.

Three demonstrations have been conducted at exhibitions — one at Madgaon, Goa (January 1981), and two at the India International Trade Fair, New Delhi (December 1981 and November 1982).

The technology has been adopted by two parties: (1) Director of Agriculture, Government of Goa, Daman & Diu, Panaji; and (2) a private industry.

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SOLAR DRIER-CUM-COOKER

(NIO, Goa)

The National Institute of Oceanography (NIO), Goa, had earlier designed a cabinet type solar drier of 100 cm × 50 cm × 35 cm size. The gadget could dry 60 large-size coconuts into first-grade copra, 10 kg of grapes into dry *kismis*, 10 kg of ripe fresh chillies into dried ones, or an equivalent weight of processed fish into flakes in one lot in about one-fifth the time required for their open-sun-drying.

To make it suitable also for cooking mid-day meals for farm workers, NIO has improvized the cooker with additional fixtures, which remain open during the drying phase, some of them closing when it works as a cooker. During the drying phase the gadget was found to record 95°C as the maximum temperature, and during the cooking it recorded 130°C as the maximum temperature (May 1983). The unit was also tested successfully to cook both rice and pulse in eight Hindalium containers in 90-120 min. The mid-day meal thus prepared was found to be sufficient for 8-10 workers. Once the cooking phase is over the gadget could be used for the drying phase. The fabrication cost of a unit is about Rs 1,200. However, by prefabrication of its components for large-scale production, the cost could be further reduced. Another feature of the design is that the gadget can be dismantled, packed and reassembled easily.

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SOLAR DRIER FOR MARINE-CUM-FARM PRODUCTS

(NIO, Goa)

Sun-drying of marine and farm products, which is the traditional method of food preservation, is the cheapest. But it is time-consuming and there are greater chances of food spoilage. Various types of mechanical drier using conventional fuels (wood, charcoal, furnace oil, electricity, etc.) have been introduced in course of time. Although these driers take less time for drying, the dried products are invariably duller in appearance and brittle. With the rising costs of conventional fuels, the use of mechanical driers is also going into disfavour.

A cabinet-type solar drier designed and developed by the National Institute of Oceanography (NIO), Goa, offers a satisfactory solution to the problem. Known as 'marine-cum-farm product solar drier', the device is about 100 cm × 50 cm × 35 cm in size. It is capable of drying 60 large-size coconuts into first-grade copra, 10 kg of grapes into dry *kismis*, 10 kg of ripe fresh chillies into dried ones, or an equivalent weight of processed fish into flakes in one lot in about one-fifth of the time required for open-sun-drying. Made entirely of indigenous components, it can be fabricated at a cost of about Rs 500. The cost could be reduced by prefabricating its components for large-scale production. The gadget can be dismantled, packed and reassembled easily.

Trials/demonstrations have been conducted at exhibitions and elsewhere: (1) India International Trade Fair, New Delhi (December 1981); (2) India International Trade Fair, New Delhi (November 1982); (3) Plant Exhibition, Madgaon, Goa (January 1981); (4) Plant Exhibition, Panaji, Goa (October 1981); and (5) Extension Training Centre, Ela (Old Goa) (March 1981).

The technology has been adopted by four parties: (1) Directorate of Agriculture, Government of Goa, Daman and Diu, Panaji, Goa—2 units; (2) Ideal Food, c/o Keshav Sinai Kunde & Co., Marmagao, Goa—4 units; (3) Indian Hotel Co. Ltd, Valpoi Valley Farm, Valpoi, Goa—2 units; and (4) V.P.S. Ayyemperumal Nadar & Sons, 35 M.C. Chidambara Nadar Street, Virudhunagar—4 units.

The raw materials are easily available from most town markets.

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SOLAR DRIER FOR APRICOT

(RRL, Jammu)

Because of the importance of apricot in the economy of Ladakh region of Jammu and Kashmir State and also because of the growing demand for this fruit within the country, the Regional Research Laboratory (RRL), Jammu, carried out systematic studies on speedy and hygienic drying of the fruit. As a result, it has fabricated a solar drier. In comparison with the sun-drying method, this drier reduces the drying time substantially. It also gives cleaner products with a longer storage life, better flavour and a more attractive appearance than those of products obtained through traditional drying in the sun.

More than 20 solar driers (each costing about Rs 500) have been adopted by fruit growers in several villages of Ladakh. In addition, farmers in Kargil have themselves fabricated a number of such units from local materials using RRL technology.

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SOLAR-POWER GENERATION

(NPL, New Delhi)

Solar-power generation by using concentrating collectors has been achieved in a number of countries such as the USA, France, Australia, etc. India, however,is not far behind. For example, the National Physical

Laboratory (NPL), New Delhi, has fabricated a concentrating-collectors system (24 m^2) capable of giving 10 kW thermal output. The first phase of this project aims at generating steam for industrial use. A prime-mover coupled to this system is designed to produce mechanical/ electrical energy in the second phase.

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SOLAR WATER-HEATER

(CBRI, Roorkee)

A solar water-heater designed and fabricated by the Central Building Resarch Institute (CBRI), Roorkee, can heat 140 litres of water up to 35°C in the afternoon, and to 48°-50°C in the next early morning during winter. While this is suitable for domestic use, another large-size water heater developed is suitable for use in hospitals, hostels and restaurants, primary health centres, veterinary hospitals, etc.; this can heat 600 litres of water in the same way.

The unit consists of two collectors of sun's rays and an insulated tank. The absorber consists of a blackened aluminium sheet of 28 gauge attached to a network of parallel galvanized-iron pipes of 19 mm dia. in such a way that there is good thermal contact between the tubes and the plate. It is housed in a cover box made of heat-insulating materials and provided with a glass window for allowing the sun's radiation to fall on the blackened plate. The absorber is oriented due south at a latitude plus angle of 15° from the horizon (i.e. L + 15°) for winter use. The absorber is connected to the storage tank kept at a certain height. Cold water at the bottom of the tank flows down to the absorber. Heated water rises to the top of the tank because of its lower density. This automatic circulation (thermosiphon) starts a short while after sunrise and stops at sundown.

On cloudy days or when the load is more than the design value, a thermostatically controlled immersion heater fixed to the tank can be pressed into service. The auxiliary equipment is available at a nominal cost.

Demonstrations

Type of heater	*Place*	*Year*
Domestic and pipe type	CBRI Colony, Roorkee	1973
Domestic unit	BEG & C Guest House, Roorkee	1975
Domestic unit	New Hostel, CBRI, Roorkee	1980
Large size (600 litres)	Ramakrishna Mission Seva Ashram, Kankhal,Hardwar	1980

Cost

The cost of a solar water-heater of 140 litres capacity is around Rs 5000 and that of 600 litres capacity is Rs 14,800.

Adoption of Technology

Four parties are manufacturing solar water-heaters based on CBRI's designs: (1) Fertiplant Engineering Co. Pvt. Ltd, Jamunotry, 26 Road, Bandra, Bombay 400 050; (2) B.S. and Services Pvt. Ltd, 53-57 Laxmi Insurance Building, Bombay 400 001; (3) Anup Engineering Pvt. Ltd, Anil

Starch Premises, Anil Road, Ahmedabad; and (4) G.S. Jain & Co. Pvt. Ltd, 48/207, Civil Lines, Roorkee.

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SOLAR WATER HEATER SYSTEM
(NPL, New Delhi)

A solar hot-water system based on a thermosiphon capable of heating 120 litres of water to 60°C has been designed and fabricated. It is estimated to cost about Rs 3500. Demonstrated at national and international exhibitions as well as at rural exhibitions in India, the system has attracted the attention of the visitors. Installed and maintained by villagers, these are supplying hot water for the past eight months in the Mathrewal village (near Amritsar).

Biogas

96
BIOGAS FROM WATER HYACINTH
(NEERI, Nagpur; CMERI, Durgapur; and RRL, Jorhat)

Water hyacinth (*Eichhornia crassipes*), an obnoxious aquatic weed abundantly available in water-logged areas, has been tried as a feedstock for producing biogas with 50-60% methane content. The left-over sludge is a good manure with high nutrient contents and acts as a good soil conditioner owing to its fibrous nature. Experiments made at the National Environmental Engineering Research Institute (NEERI), Nagpur, show that cattle-dung and water hyacinth, mixed in the ratios of 3:1 and 1:1 at an organic loading of 1.6 kg of volatile solids/m³/day and a detention time of 30 days, can yield 30% more gas than with cattle-dung alone.

A biogas plant designed by the Central Mechanical Engineering Research Institute (CMERI), Durgapur, produces 3000 litres of gas per day in summer. This also uses water hyacinth as a feedstock. It is a horizontal plant with a steel floating dome; has a vertical feed-pipe at one end for easy feeding of the vegetable matter by pushing with a bamboo; has sloping roof and floor which helps the passage of light-weight vegetable matter and its sludge towards the outlet; and has a big outlet of suitable dimensions for easy disposal of partly decomposed sludge.

The biogas produced is sufficient for cooking, through a medium-size burner which consumes 450 litres/hr; or for illumination through a 100 cp gas mantle which consumes 140 litres/hr.

The Regional Research Laboratory (RRL), Jorhat, is engaged in standardization so as to develop field-scale prototype digesters and an optimum operational design.

Two demonstration plants (with fixed roof) of 300 litres capacity, having different dimensions and feed systems were run for several months in the Central School premises of CMERI Colony and in the institute's campus at Durgapur.

A horizontal-type design with floating dome gas collection chamber was tried to scale up the laboratory model (fabricated from steel sheets). This design has overcome the various difficulties faced while working

on the fixed-dome-type demonstration plants and various other models.

The Bihar government had since shown interest in establishing three plants in schools and agricultural farms; it has also sanctioned 50% of the estimated cost so that PTC, Patna, could take up the job.

Cost

The cost of the plant is Rs 6500 as estimated in 1981 in accordance with West Bengal PWD rates.

97

BIOGAS PLANT
(CBRI, Roorkee)

Biogas plants are becoming more and more popular in rural areas. These are of two designs: one of movable dome-type made of metal, and the other of a fixed-type made of masonry. A study undertaken by the Central Building Research Institute (CBRI), Roorkee, has shown that both the designs have drawbacks. These are: (i) corrosion of metal gas holder and its high cost; and (ii) leakage of gas through masonry dome, posing problems in maintenance.

The institute is therefore developing corrosion-inhibiting paints for metal gas holders. It is also modifying the design of fixed masonry dome to reduce its cost and leakage of gas.

An improved biogas plant has been installed (1983) in the village Mewad, near Roorkee.

Under an All-India Coordinated Project on Utilization of Biogas Technology, CBRI is examining: (i) the structural aspects of the 'Janata' biogas plant developed by the Planning Research & Action Division of the State Planning Institute, Lucknow; (ii) a suitable design for a small-capacity biogas plant; (iii) prevention of leakage of gas through ferrocement gas holders and fixed masonry dome-type; (iv) prevention of corrosion of steel gas holders; (v) gas distribution systems for

Biogas plant of CBRI design

community biogas plants; and (vi) making comparative economics of biogas vis-a-vis other fuels.

In the first year of the project, the design of 'Janata' biogas plant was finalized, the teething troubles having been solved, and a prototype plant has been constructed in the institute. The plant is functioning satisfactorily. No leakage of gas through the vulnerable joint at the junction of the well and dome was noticed. Field trials of the corrosion-inhibiting coating (for steel gas holder) at KVIC centres at Gandhigram (Tamil Nadu) and Nasik (Maharashtra) have been very satisfactory. Similarly, trials on coatings on ferrocement gas holders at Gandhigram and at SERC, Roorkee, have also been very encouraging. The final report of the project is being prepared.

98

BIOGAS PLANTS CONNECTED TO SANITARY LATRINES

(NEERI, Nagpur)

Owing to shortages of firewood, villagers use cattle-dung cakes for cooking and, hence, a large amount of cattle dung, which is a very rich source of organic manure and could be more profitably used as a source of organic manure, is consumed as cooking fuel. Subjecting cattle dung to anaerobic digestion gives a product containing methane gas (to the extent of about 55%) and this gas could be conveniently used as a smokeless fuel for cooking. This method provides an effluent slurry which is quite rich in fertilizing constituents like nitrogen, phosphorus and potash and can be profitably used as fertilizer. Addition of human excreta in proper proportion to animal dung (1:10) makes the mixture more amenable to digestion, gives a little extra gas (10-12%), and also enriches the manurial value of the effluent slurry. The National Environmental Engineering Research Institute (NEERI), Nagpur, has constructed such a demonstration cattle-dung digestion plant connected to a sanitary latrine, also of the institute's design, in one of its project villages around Nagpur. The technology proved not only successful at the field level but was also found acceptable to local villagers.

A 4 m^3 capacity cattle-dung digestion plant has been constructed in a family farm. The digester well is in brick masonry and the gas holder (fabricated at NEERI) is made of mild steel. The plant is connected to a hand-flush water-seal sanitary latrine of NEERI's design. Night soil is received in a mixing chamber where it is mixed with cattle-dung from 8-10 cattle-head and fed to the digester having about 40 day's detention period. The gas produced is carried through a galvanized-iron pipeline to the kitchen in this farmer's house where it is used for cooking. The plant thus simultaneously treats night soil and cattle dung. The effluent slurry is taken into a leaching-cum-evaporation pit lined with brick masonry. The dried slurry is used as a manure by the farmer in his orange garden.

99

COLLAPSIBLE STIRRER FOR BIOGAS PLANTS

(SERC, Roorkee)

In biogas plants, intermittent stirring of the slurry improves gas production. A collapsible stirrer developed by the Structural Engineering Research Centre (SERC), Roorkee, for use in biogas plants of conventional designs contributes to their efficiency. The stirrer can be introduced through the inlet with the blades in folded position. A rotating arrangement is provided at the top, by rotating which the blades open out because of centrifugal force, thereby stirring the slurry. After the stirring is over, the blades are made to collapse in the opposite direction owing to gravity, and the stirrer is taken out. It is capable of stirring to a radius of about 25 cm, which is quite effective for small-capacity biogas plants. For plants of larger capacities, the blade length can be increased.

Made of steel, the stirrer consists of a stem, handle and three collapsible blades. It can be easily fabricated in a workshop. The stirrer costs about Rs 250.

100

FERROCEMENT BIOGAS DIGESTER

(SERC, Roorkee)

A system of using ferrocement precast segmental units for constructing digesters for biogas plants (3.0 to 8.0 m^3 gas per day) has been developed and tested at the Structural Engineering Research Centre (SERC), Roorkee. The digesters are assembled with 4, 6 or 8 precast segments 15 to 18 mm thick. The wiremesh and wire reinforcement projecting on sides are used for connecting the segments when placed in a vertical position. The mesh laps form the joint ribs and also accommodate the inlet and outlet pipe junction with the digester wall. A rich cement-sand mortar is applied over the mesh joint areas and ribs are formed. Extra reinforcement could be provided in the joints and radial bands, projecting out at top, middle and bottom positions.

If this technique is adopted for construction of the digester in areas where good bricks are not available or where mass-scale construction of biogas plants is to be taken up, it will save considerable expenditure and construction time.

Demonstrations/trials have been conducted at several exhibitions and places:

Wardha (Maharashtra), Science for Villages Exhibition —1978	Biogas holder for $3m^3$ plant; components for biogas holder; demonstration of casting method to rural artisans
Karimnagar (A.P.)—1977	Demonstration of casting, assembling and erection method for gas holders and digesters to entrepreneurs.
India International Trade Fair, New Delhi — 1978 and National Trade Fair — 1979	Gas holders for $3m^3$ and $6m^3$ plants and digesters
Agriculture Exhibition, Madgaon (Goa) — 1980	Gas holder for $3m^3$ and $6m^3$ plants and digesters

Ferrocement digester for biogas plants

CHOGRM-2 Exhibition, New Delhi — 1980

Agriculture Fair, P.A.U., Ludhiana—1981

Full-scale working of biogas plant with ferrocement gas holder

Biogas holder for 3m³ plant

Three biogas plants have been erected in the campus of SERC, Roorkee. One digester is also displayed at this laboratory campus.

Two training courses were organized for polytechnic teachers and field engineers at Roorkee in 1979 and 1981.

Adoption of Technology

Two biogas plants have been erected at Officers' Mess, Roorkee.

All necessary raw materials are available in the open market.

Cost

Gas holders 3m³ plant	Rs 600, which includes cost of central pipe for the guide
6m³ plant	Rs 1380, which includes cost of central pipe for the guide
Digester 6m³ plant	Rs 2700/unit.

101

FERROCEMENT BIOGAS HOLDER

(SERC, Roorkee)

In the conventional biogas plants, gas holders made of steel sheets are used. Such gas holders account for nearly 40-50% of the total cost of the plant. Besides, the steel gas holder has low life and needs expensive maintenance, as it is highly susceptible to corrosion. The ferrocement

Ferrocement holder for biogas plants

(cement-mortar reinforced with steel wiremesh layers) gas holders, designed for biogas plants of 2-6m³ capacity gas production per day, have been found 40-50% cheaper than steel gas holders. Other advantages are that the ferrocement holder needs much less maintenance and has a much longer life. It can be fabricated in rural areas without expensive equipment, but requires good quality control during production and careful handling during transportation and installation for preventing mechanical damages.

The estimated cost of a ferrocement gas holder for a 2m³ capacity plant is Rs 600.

102

NIGHT-SOIL DIGESTER WITH GENERATION OF METHANE GAS

(NEERI, Nagpur)

To prevent indiscriminate dumping of night soil and its unhygienic handling on farms in raw condition, the National Environmental Engineering Research Institute (NEERI), Nagpur, has designed a night soil digester. The digester oxidizes organic matter, rids the material of obnoxious odour, eliminates pathogenic organisms, provides sludge as manure, and yields methane gas for domestic use.

The digester is a masonry structure partly above and partly below the ground with a floating gas dome at the top to collect the gas generated in the digester. There is provision in the digester to feed night-soil slurry and withdraw the digested sludge and the supernatant. The digester can be constructed and also run economically for a population of 250 or more provided the gas is utilized nearby.

A demonstration plant was set up by NEERI at the Central Prison, Nagpur. The plant has a working volume of 18 m³ and a gas storage capacity of 8 m³. The plant was operated for four years. The organic loading in the digester was 1.6-2.2 kg of volatile solids/m³/day depending on the ambient temperature. A volatile solids destruction of

41-50% with a gas production of 0.43 – 0.45 m^3 per kg of volatile solids added was observed. Per capita gas production worked out to be 0.025 m^3/day.

The gas contains 60-65% methane and 35-40% carbon dioxide with traces of hydrogen sulphide, the calorific value of methane being 5660 kcal/m^3. The digested slurry from the digester is withdrawn on the sludge-drying bed and allowed to dewater and dry. The filtrate from the drying bed is further treated in a stabilization pond. Manure in the form of sludge cake is rich in nitrogen (N, 3.25%), phosphorus (P, 1.00%) and potassium (K, 0.83%).

Studies to eliminate helminthic parasites at various loadings indicated that ascaris and hookworm in ranges of 35.3-52.0% and 65.3-70.3% respectively could be removed.

Cost

For a digester of 10 m^3 capacity, 200 people's night soil is needed; the volume of gas produced is 5 m^3. The plant costs about Rs 9,000.

Adoption of Technology

The technology has been adopted at seven places: (1) Ramakrishna Mission, Coimbatore; (2) Agriculture College, Rahuri, Maharashtra; (3) Sulabh International, Patna, Bihar; (4) Burujwada village, near Nagpur; (5) Garden Reach Municipality, Calcutta; and (6) Delhi Cantonment Board, Delhi. In the Patna plant, only night soil is used, while in others, mixtures of night soil and cattle dung are used.

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STEEL BIOGAS HOLDER—CORROSION PREVENTION BY SACRIFICIAL ANODES

(CSMCRI, Bhavnagar)

The average life of a biogas plant, as estimated by the Khadi & Village Industries Commission, is about 10 years but sometimes the plant fails in about five years as a result of localized corrosion and pitting of the gas holder.

Any ferrous metal placed in contact with water gets corroded. Corrosion is a continuous electrochemical process that results in destruction of metals. An electrochemical method of preventing corrosion, known as cathodic protection, is used to prevent corrosion of metallic structures in electrolytes, waters and soils. It is the reverse of the corrosion process.

As a result of the work done at the Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar, it is possible to provide cathodic protection to mild-steel holders as temperature, *p*H and other conditions of the digesting slurry in a biogas plant are known. The method is cheap and can be easily adopted by farmers in villages; it requires no supervision or maintenance. Technical details of the placement of special type of sacrificial anodes and design information dependent on the capacity of the plant feed used, can be obtained from CSMCRI.

NATURAL RESOURCES
— Exploration and Utilization

TISSUE CULTURE EXPERIMENT IN PROGRESS

Natural Resources — Exploration & Utilization

Natural resources could be broadly grouped into two categories: resources above the ground, and those underground. The resources above the ground are land (soil), water, flora and fauna. Equally important are the solar energy, and above all, human resources. The underground resources include principally ores and minerals, groundwater, and gas. Exploration and utilization of natural resources started with the dawn of civilization when 'man and environment' existed in harmony. But with the explosive growth of population the equilibrium between 'man and environment' became unstable, because of injudicious application of science and technology in this century. To restore the equilibrium, man has necessarily to take recourse once again to science and technology. It is through this instrument alone that he can hope to achieve judicious utilization of land for farming, upkeep of forests, harnessing of non-conventional sources of energy, optimum and judicious utilization of mineral and forest wealth and such other resources. It is in this context that scientific management assumes prime importance. The approach involves a systematic inventory of natural resources through geological surveys, geohydrological surveys, forest surveys, soil surveys, etc. Modern remote-sensing methods have opend up new possibilities for speedy and reliable surveys. The application of S & T thus helps not only in the generation of new assets, but also opens up avenues for new work opportunities, and potential for maximum payoff. Many of the CSIR laboratories are seized of the problem and are addressing themselves to its solution. While tackling the problem from the national perspective, these CSIR constituents have also focused attention on resource surveys which would contribute to improving the quality of life of the rural masses. The National Geophysical Research Institute, for example, has devoted considerable attention to the development of the backward Karimnagar district in Andhra Pradesh.

Of all the natural resources mentioned earlier, water is of paramount importance. In the context of natural resources, water means rainfall, artificial taming and collection of water for drinking and for other household needs and for farming. The source for both ground and surface water is precipitation. The NGRI's water resources programme is a priority programme, especially in drought-prone and semi-arid zones. Scientific surveys and planning of the water resources, and a detailed analysis of available precipitation data, have been carried out.

Hydrological surveys and groundwater exploration through test drilling operations help not only in locating sources of groundwater in depth, but also in identifying associated technical management aspects. This task is being undertaken by NGRI, Hyderabad. This laboratory's work in instrumentation and computational techniques has aided the resource survey work.

Geophysical and geohydrological studies play a very crucial role in all stages of groundwater development. The areas in which NGRI has taken up R&D work relate to methodology and interpretation and groundwater management using various scientific models. Other aspects studied are location of water sources in relation to yield of water, criteria for installation of borewells and tubewells, and methods of improving water-charge and recharge.

104

CITRONELLA CULTIVATION AND PROCESSING

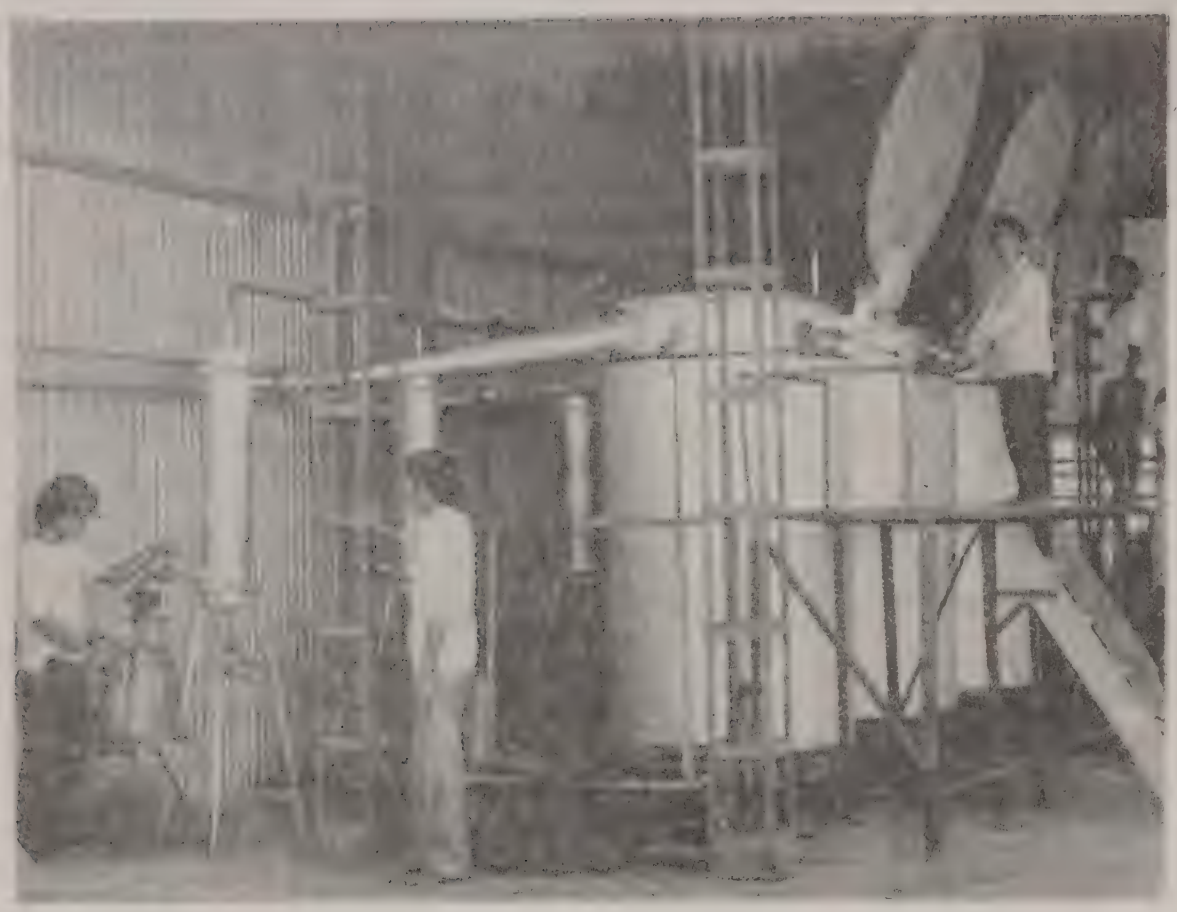
(RRL, Jorhat)

For the past hundreds of years or so Naga families of Yaongyimsen village of Nagaland had been resorting to only shifting cultivation (*jhumming*) of citronella and had been living completely at the mercy of nature. At the Yaongyimsen village an experiment-cum-demonstration centre of citronella cultivation was started in 1970 by the Regional Research Laboratory (RRL), Jorhat. The villagers were motivated to adapt citronella cultivation. In 1971, 5 out of 350 families of the village took to cultivation and brought an acre under citronella. That was a unique experience for the Nagas.

Gradually, more and more Naga families of the village started participating in the RRL programme, bringing more and more land under citronella cultivation. The laboratory designed, fabricated and installed a distillation plant and the Department of Industries of the Government of Nagaland was brought into the scene. The unit started distilling the grass, and the villagers started selling the oil and earning handsomely (an acre of land producing annually 30 tonnes of citronella grass valued at Rs 15,000 in 1971). Initially, the distillation plant had a 200 kg/batch capacity, which could not cope with the increasing production of grass. Hence, another still of the same capacity was installed.

As the cultivation further extended, new distillation stills of higher capacity were installed. The Director of Industries of the state government, impressed by the socio-economic soundness of the programme, provided a sum of Rs 2.6 lakh to this CSIR laboratory for designing, fabricating and installing a sophisticated distillation plant on a turn-key basis. In 1979 the Nagaland government installed another distillation plant of 800 kg/batch capacity in this village. As a result of the promotional activities of RRL, 281 families of the village brought some 210 acres of land under cultivation and produced nearly 6000

Citronella cultivation at Yoangyimsen village in Nagaland



Citronella distillation plant at Yoangyimsen in Nagaland

tonnes of grass valued at about Rs 30,00,000 (1983). The annual income per family rose to more than Rs 8,000.

Apart from selling citronella grass, the villagers got an opportunity to sell firewood to the distillation plant. Some villagers also secured employment in the distillation units. This laboratory also trained a few villagers to work in these plants.

The example of Yaongyimsen village induced other villages of the North-Eastern Region to take to such programmes.

Arising from the promotional as well as research and development activities of RRL, the land under citronella cultivation has increased phenomenally—from a few hectares in 1971 to 4143 ha in 1983. The estimated production of citronella oil in the region during 1983 was about 6,30,000 kg valued at Rs 5,35,50,000, taking an average selling price of oil at Rs 85 per kg (1983). Nearly a thousand families are engaged in citronella cultivation.

Several individuals as well as groups of individuals sponsored by various organizations have been trained by this laboratory during the last two years. The technology has been adopted in 21 villages in the region.

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CLOCIMUM CULTIVATION —A NEW MEDICINAL-CUM-AROMATIC PLANT

(RRL, Jammu)

Clocimum (clove-scented *Ocimum*) is a hybrid strain of *Ocimum gratissimum* developed by the Regional Research Laboratory (RRL), Jammu, as a cheap substitute for clove oil and as a cheap source of eugenol. Clove oil and eugenol are important essential oil items of great demand in perfumery, flavouring and pharmaceutical industry. These

sources of eugenol are highly prized and India has sometimes to import both clove oil and eugenol to meet the ever-increasing demand for these. It is against this background that RRL, Jammu, undertook an intensive research programme some 12 years ago to find out and develop a new and cheap substitute for clove oil and eugenol from indigenous sources.

Many industrial establishments in the country, including major firms like Hindustan Levers Ltd, Industrial Perfumes Ltd, Saiba Industries and many other medium industrial outfits, have approved the quality of clocimum oil and have switched over to this oil in their product-line.

As a part of this laboratory's lab-to-land programme to bring the fruits of research to rural areas, extension work to encourage rural farmers to take up the cultivation of *Clocimum* was undertaken. Demonstrations were conducted on some private farmers' lands. The laboratory also supplied free seed material and technical know-how for cultivation to the rural farmers in J & K State, who came forward to take up the cultivation of *Clocimum*. At present, there are about 25 acres of land under *Clocimum* cultivation in Jummu district and over 500 acres in other parts of the country. More and more farmers are coming forward to take up the cultivation of this new plant released by RRL.

CUTIVATION OF PROTEIN RICH ALGAE

(NBRI, Lucknow)

As a part of the R&D work on under-exploited protein-rich algae, the National Botanical Research Institute (NBRI), Lucknow, has developed a biotechnology for cultivation, in raw sewage, of *Spirulina platensis*. This is a multi-cellular, filamentous, planktonic blue-green alga, which affords an excellent vegetable protein (55-60%), and is a rich source of vitamins, pigments, minerals, and trace elements. The average yield is one metric tonne per year of dry alga, containing 55% crude protein, from a 60,000-litre open-air pilot production unit, in operation at NBRI.

The algal biomass has been found to be very useful as a protein substitute, in place of maize, millet, groundnut cake, etc., in poultry and cattle feed. The sewage water gets reclaimed in the process to be utilized for irrigation and pisciculture.

Economics

Assuming an algal yield of about one metric tonne per year, calculated at 6.5 g/m²/day growth rate, and taking into account the necessity of changing the entire pond contents every six months, the annual inputs and turnover for 450m² production ponds, with a capacity of 60,000 litres, were found to be as follows:

Non-Recurring	Rs
Construction of algal production ponds	1,75,000
One air compressor (5 hp)	12,000
One motor pump (5 hp)	3,500
Pipe fittings	12,000
Metallic stirrer	500
Total	2,03,000

Recurring		
Chemicals		
Sodium bicarbonate — 1200 kg @ Rs 3.50/kg		4,200
Sodium nitrate — 720 kg @ Rs 8.00/kg		5,760
Personnel		
Supervisor—one, with a monthly salary of Rs 500		6,000
Labourers—two, hired @ Rs 8/head/day		5,840
Power		1,500
	Total	2,33,000
Overhead expenditure @ 10%		2,330
Total recurring expenditure		25,630
Cost of 1000 kg of the alga		25,630
Cost of 1 kg of the alga		26

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HOPS CULTIVATION AND POST-HARVEST TECHNOLOGY

(RRL, Jammu)

Hops (*Humulus lupulus*) is an essential ingredient in the manufacture of beer. The Regional Research Laboratory (RRL), Jammu, has developed agro-technology by evolving a variety of this plant which gives higher yields, contains higher alpha-acids content, and is rich in aroma and resistant to local pests and diseases. By studying the effect of dressing on the flowering behaviour and yield, a technique has been evolved by which a yield of 2,225 kg hops per ha could be obtained as against the earlier one of 700 kg only. The yield compares well with yields in other countries.

For post-harvest processing, which is a very specialized operation, RRL has designed a kiln to dry the produce. The drier works on the principle of through bed drying with an induced draught. Multiple-grilled and wire-netted (perforated) beds are provided in drying rooms. The samples produced with this technology have been approved by the international hops marketing agencies.

The RRL's demonstration of the technique has encouraged many farmers to take up the cultivation of this economic crop. Training courses have also been organized for prospective growers of hops in Kashmir Valley and Himachal Pradesh. Based on the technology, Kashmir Valley is now producing hops worth more than Rs 50 lakh a year.

Besides supply of the propagating material and preparation of feasibility report on cultivation and processing technologies, RRL provided technical guidance and consultancy. A hops-drying unit (provided on turn-key basis by RRL) has been installed at Sumbal for the Agriculture Department of J&K State.

Hot air is made to pass through the hops beds over which hops flowers are kept. A mechanical device is provided for the transfer of semi-dried flowers to the lower bed. Dried flowers are made into bales, for easy transportation, under a hydraulic pressure of 50 kg/cm^2.

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MAKHANA (Euryale ferox) CULTIVATION

(RRL, Jammu)

Makhana (Euryale ferox) is a costly dry fruit mostly grown in Bihar, Bengal and Assam. Its cultivation in the Jammu & Kashmir region has not been attempted so far.

The Regional Research Laboratory (RRL), Jammu, has therefore started experiments to raise this crop in the region. Seeds of *makhana*, procured from Assam, were sown both in an experimental tank and in a farmer's pond at village Khor. The farmer has harvested a large number of fruit from the pond (25 m^2). The experiment, started in 1982, has encouraged the farmer to take up further cultivation.

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MEDICINAL & AROMATIC PLANTS—CULTIVATION AND PROCESSING

(CIMAP, Lucknow)

Higher plants have been used as a source of drugs in India for more than two thousand years. The present-day rural population of the country and a large portion of the urban population are still dependent on the traditional system of medicine practised in this country where more than 90% of the drugs are derived from plants. Even in the modern system of medicine more than 25% of the drugs prescribed today contain one or more derivatives of higher plants. Similarly, most of the

Pilot plant for extraction of rose oil from *Rosa damascena*; of 25 kg flowers per batch capacity; fabricated and installed by CIMAP at the village Hasayan in Aligarh dist. (U.P.). The yield of oil obtained was 0.018% and its quality was adjudged to be at par with that of the Bulgarian rose oil. The yield with this technology was four times that with the traditional country-made stills. The technology has been purchased by Agra Mandal Vikas Nigam, Agra (U.P.).

raw materials required in the perfumery, cosmetic and flavour industries are also obtained from essential oil bearing plants. Recognizing the importance of plants in modern medicine, perfumery and cosmetic industries and in order to develop necessary agro-technology and processing technology for these plants, the CSIR set up a number of institutions so as to make the country self-sufficient in these plants and also to encourage export of raw material as well as active constituents. One of the main reasons for taking up research projects on medicinal and aromatic plants was to develop such small-scale technologies as are suited to rural areas and as can be used for increasing the cash income of small farmers and provide additional job opportunities to the rural population.

As a result of research and development carried out during the last 30 years it has been found that a large number of medicinal and aromatic plants can be cultivated in one or the other region of the country by small farmers along with traditional food and cash crops without disturbing the present land utilization pattern in the country and without decreasing the production of food crops; e.g. Japanese mint (*Mentha arvensis*) can be grown in rotation with rice and early mustard or it can be cultivated after a crop of early maize, followed by potato crop, thus giving very high income to the farmers. Similarly, some of the other essential oil plants like *citronella* and *patchauli* can be grown as intercrops along with plantation crops, giving additional yield to the farmers. Some of these plants can be easily fitted into agro-forestry system.

As a result of demonstration of various technologies for cultivation and processing of such plants by the Central Institute of Medicinal & Aromatic Plants (CIMAP), Lucknow, a large number of small and medium scale farmers have taken up scientific cultivation of these crops in different parts of the country.

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MUSHROOM (DHINGRI) CULTIVATION

(RRL, Jammu)

Dhingri (Pleurotus sp.) is a highly edible mushroom relished by people of all walks of life. It grows wild extensively in Jammu & Kashmir. The Regional Research Laboratory (RRL), Jammu, took the initiative to raise this crop artificially by farming on scientific lines.

The method consists in cutting paddy straw into pieces, 10-12 cm long and soaking them in water for 36-48 hr after which the straw is removed and properly drained. The straw is then put in polythene bags (3 kg/bag). After incubating the bags in a room, the mycelium is inoculated and the bags are kept in a room with proper aeration. The blocks are regularly irrigated and the mushrooms start appearing after 4 to 5 days.

Four to five crops can be easily harvested from a block and about 300 g of *dhingri* obtained from a bag.

Dhingri is easily dried in sun and gives very good return to farmers. RRL supplies spawn to needy farmers regularly. Many farmers in Kashmir Valley have now taken up cultivation of *dhingri* based on the technology provided by this CSIR laboratory.

Dingri mushroom (*Pleurotus* sp.) cultivation on agro-waste

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RAISING OF FAST-GROWING FIREWOOD PLANTS

(RRL, Jammu)

Firewood, a vital material in the lives of rural people, is steadily becoming scarce and as a result its prices are soaring. Realizing such an alarming situation of the rural poor, the Regional Research Laboratory (RRL), Jammu, has made concerted efforts to supplement firewood needs of the rural communities. The initial efforts were aimed at raising plantations of fast-growing species. In Jammu & Kashmir, the availability of land is not a constraint to the success of implementation of firewood plantation programmes. The major constraint was, however, the selection of the right species and suitable agrotechnology for raising firewood plantations on sites of poor fertility, which could give maximum yield in terms of biomass.

The RRL, Jammu, initiated in 1979 a programme of research and development to solve the problem. It introduced and evaluated a number of fast-growing tree species and identified a few which could be developed as firewood crops in the region. Species so far identified for this purpose are *Leucaena eucocephala, Gmelina arborea* and *Sesbania sesban*. All these coppice vigorously and lend themselves to harvesting at short intervals of 2-3 years. They also give several crops year after year. There has been much demand for seeds of these species from all over the country. For example, over the last four years (1980-1983), RRL has sold seeds to the extent of about 3000 kg worth about Rs 90,000.

Requests for supply of not only seeds, but also for providing technical advice for raising plantations, are being received. Progressive farmers in several states have set up their own plantations with the technical guidance from this laboratory.

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TISSUE CULTURE

(NBRI, Lucknow)

At the National Botanical Research Institute (NBRI), Lucknow, a number of commercially important orchids, viz. *Cymbidium, Dendrobium, Paphiopedillum, Rhynchostylis* and *Vanda* and several other ornamentals, viz. *Amaryllis, Bougainvillea, Chrysanthemum, Gailardia, Gladiolus, Lillium, Petunia hybrida,* and *Polianthes,* have been propagated by tissue culture.

Methods for mass and rapid clonal propagation of some medicinal plants, like *Dioscorea deltoidea, D.floribunda, Solanum khasianum, Costus speciosus, Rauvolfia serpentina* and *Rosmarinus officinalis* have also been developed and the *in-vitro*-regenerated plants have been grown in soil. Seed sterility in *R. serpentina* has been fully overcome by embryo culture.

A most intractable woody plant, *Simmondsia chinensis* (jojoba), has been multiplied *in vitro* and successfully transplanted in soil. Other trees regenerated from cultures are sal (*Shorea robusta*), teak (*Tectona grandis*) and *Mitragyna parvifolia.* Androgenesis, which is a very rare phenomenon in trees, has been induced in *Citrus,* while triploids have been produced from endosperm culture of sandalwood (*Santalum album*).

Shoot tip culture has been perfected and nucellars have been produced of *Citrus* for virus elimination.

An innovative method for germplasm preservation has been developed by establishing long-term culture of excised roots and regenerating plants from them.

A tissue bank has also been established through proliferating shoot cultures of a number of plants.

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TISSUE CULTURE
(NCL, Pune)

The technique of plant tissue culture is becoming increasingly popular for rapid propagation of plantlets of agricultural value, for ridding plants of diseases, for screening agriculturally important mutants, and in the study of cloning, differentiation and somatic hybridization of plant cells. The technique has found wide application in forestry for quick multiplication of trees which grow slowly or which do not breed true by conventional methods.

Researchers at the National Chemical Laboratory (NCL), Pune, have built up a strong school in this growing area of research. One of the important contributions of this school is the development of a mosaic virus-free sugarcane variety (Co-740). Sugarcane plants raised directly from callus and after treatment with mutagenic agents have also been screened for disease resistance.

A vegetative method for propagating high-yielding hybrid cabbage is also available as a result of NCL's work. The feasibility and economics of seedling production in large scale have also been investigated.

The tissue culture technique has been used by NCL's researchers for multiplying forest trees like teak and eucalyptus and spices like turmeric and cardamom. The propagation of ginger, pomegranate, tamarind and rose has also been achieved and visible plants have been successfully raised in the field.

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WATER CHESTNUT CULTIVATION
(RRL, Jammu)

While surveying the water bodies of the J & K region for cultivation of fishes, the Regional Research Laboratory (RRL), Jammu, found that a number of ponds are not commercially viable for fishery development. This laboratory therefore introduced cultivation of water chestnut (*Trapa bispinosa*) (*singhara*) in such ponds for the first time in the region. By and by, the farmers realized the economic benefit of the cultivation of *singhara* so much so that at present it is being cultivated on a large scale in Khor and Arniya villages of Jammu region.

Cultivation of water chestnut

Animal Resources

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CONVERSION OF DESTRUCTIVE JUVENILE PRAWN FISHERY INTO PROFITABLE SEED FISHERY

(NIO, Goa)

One of the major bottle-necks in the development of shrimp aquaculture is the scarcity of seeds at the opportune time. At the same time, large quantities of shrimp seeds/juveniles are destroyed by certain groups of fishermen engaged in the capture of juvenile prawns for their sustenance. A technology developed at the National Institute of Oceanography's regional centre at Cochin has helped in retrieving the juvenile catch alive so that they could be utilized as seed for shrimp culture. A hand-operated aerator, designed and fabricated here, for the use of fishermen engaged in juvenile fishery has helped keep their catch alive and active so that they could be transported to shrimp farms from the capture grounds. So simple is the technique of sorting, handling, aerating and maintaining the live juveniles of prawn in good condition that the fishermen could learn and practice it in a short time. Since seed fishery is ten times as profitable as the traditional capture of juvenile fish, more and more fishermen are willing to adopt the new techniques.

Three trials and four demonstrations have been carried out so far. Demonstrations have also been carried out with the cooperation of six families.

A few families in Eranakulam district have adopted the technology.

As the adoption of technology leads to conservation of juvenile fish, fishermen are willing to cooperate in the programme. More important, the technology improves their income at a time when the catch rate from natural waters is decreasing.

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MUSSEL CULTURE

(NIO, Goa)

Of all the cultivable species of seafoods, edible bivalves — such as oysters, mussels and clams — are ideal for cultivation because they are sessile, filter-feeding, and highly tolerant to environmental changes, besides possessing prolonged breeding habits and a high growth rate. The spats of mussels, collected from their natural habitat, are transplanted and grown on hanging ropes suspended from floating rafts. A raft is made of a wooden frame and bamboos fixed on to four floating barrels and is moored by a steel anchor or a large stone. The initial investment is within the means of fishermen or poor folk interested in this activity. The technique of mussel culture is the result of the work of the National Institute of Oceanography (NIO), Goa.

The raft culture techniques for green mussels have given the following encouraging results:

- The growth was 50% faster than in their natural habitat.
- Marketable size of 60 mm was attained much faster in cultured animals than in the natural population.
- A high annual production of 60 kg of flesh per metre was achieved as against less than 1 kg under natural conditions.
- A high rate of return of about 180% could be obtained on investment.
- The cultured animals contain high protein (56.03%) and possess a high calorific value (5.95 kcal/g).

The direct and indirect costs have been estimated to be Rs 1550 and Rs 900 respectively per hectare. Profit on the investment has been estimated to be Rs 4450 per hectare.

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PADDY-FIELD SHRIMP CULTURE

(NIO, Goa)

Applying modern scientific principles of ecology and aquacultue, the National Institute of Occanography's regional centre at Cochin has developed improved technology of paddy-field prawn culture. The technology pertains to the improvization of the traditional practices and introduction of new techniques such as retrieving and conserving the undersized juveniles by incorporating nursery ponds, elimination of weeds and predators, and augmenting the growth by low-cost supplementary feeding. A technique of short-term high-density

Prawn culture system showing sluice gate fixed and getting filter bag ready for catching operation

Prawn harvested from paddy field

farming of prawn developed here helps in taking two harvests a year instead of a single harvest in the traditional manner. The total or partial application of the improved technology not only enhanced the quality of prawn, but also increased the annual prawn yield (1000-1750 kg/ha) as against 600-800 kg/ha by the traditional method.

Four demonstrations were conducted during 1978-1982 followed by several demonstrations with the cooperation of shrimp farmers.

Several shrimp farmers have adopted the improved technology in Ernakulam district.

Prawn farmers are generally benefited economically by the adoption of the new technology. The element of gambling involved in the traditional practice is getting reduced and the scientific method of farming is instilling a new confidence in the farmers.

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RURAL AQUACULTURE
(RRL, Jammu)

The Jammu region is rich in both manmade ponds and tanks and also possesses ample running-water bodies.

Following an exhaustive survey of the region's potential for fish-farming the Regional Research Laboratory (RRL), Jammu, has introduced and acclimatized six different varieties of fishes including exotic ones. These varieties were subjected to breeding on a large scale, and as a result there was great demand for fish seed, the production of which then became another development activity. Every year about a lakh fish seed was distributed to fish farmers in the Jammu region. The growing popularity of fish farming has spread in recent years to both private farmers and military units, who are preparing their own ponds for taking up fish cultivation as a commercial venture for the first time in the region. Such ponds have been dug and stocked in Sherpur and Phara villages of Kathua district and Dangsal area of Udhampur district. In military units, a number of ponds scattered in Jammu and Udhampur districts have been dug by using the technology as well as the stock provided by RRL.

Encouraged by the success of fish technology introduced by RRL, UNICEF has provided aid to the extent of Rs 10 lakh, in cash and equipment, for training of officials and village youths in fishery technology. Training courses (2-4 weeks) have been organized by RRL for block development officers and other officials as also for rural youths from various parts of the region.

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WASTE UTILIZATION IN AQUACULTURE
(NIO, Goa)

An appropriate wastes-utilizing technology evolved at the National Institute of Oceanography's regional centre at Cochin has helped improve the rural economy. The technology utilizes untapped resources such as derelict waters of the coconut grove canal system, agricultural wastes like tapioca leaves, paddy stumps and weeds, besides the seeds of the popular estuarine fish like the pearl spot and mullets, which are wasted in the traditional destructive fishing. Using the differential temperature technique developed here, farmers are able to collect large numbers of seeds of pearl spots and mullets from the enclosed brackish water system such as paddy fields and grow them in coconut grove canals, whose life-carrying capacity has been improved by a desilting and clearing technique. Agricultural wastes like tapioca

Stocking of fish seed in a village pond near Jammu

leaves rich in protein (20-34%) are used as feed after subjecting them to a simple processing technique. Applying the technology, rural fish farmers could produce fish valued at Rs 10,000/ha in six months from the derelict waters.

Four demonstrations have been conducted. Demonstrations have also been carried out with the cooperation of local fish farmers.

Several fish farmers in Ernakulam dist. have adopted the technology.

The programme of using the waste resources has created awareness among the fish farmers on the potentiality of judicious use of such wastes in improving their economy besides creating a sense of conservation of natural resources. Improvement of ecology of the canal systems for introducing fish has helped reduce pollution and breeding of harmful mosquitoes while improving the rural economy.

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SEARCH FOR MORE GROUNDWATER

(NGRI, Hyderabad)

The country has an estimated 100,000 or more villages without any source of potable water and another 150,000 villages without adequate water supplies. With the growing population, intensive agricultural programmes and industrialization, the demand for water is rapidly outpacing the rate at which surface and groundwater supply schemes are being developed and commissioned.

The agriculture-based economy of the country is primarily dependent on monsoon rains which last only a few months in a year. Hence total utilization of rain-water becomes imperative. Conjunctive use of surface and groundwater resources during lean months—an approach planned and worked out by the National Geophysical Research Institute (NGRI), Hyderabad — goes a long way in meeting the water needs of the country

R&D in Ground water Resources

Groundwater has some distinct advantages over surface water. It is present practically everywhere, although its quantity, quality and mode of occurrence vary from place to place. Unlike surface reservoirs, groundwater reservoirs do not cover cultivable land and are protected against evapotranspiration losses and pollution. Furthermore, large capital outlays are not required, and returns of capital by way of project benefits start immediately.

Geophysical Exploration

It has now been well established that the success-to-failure ratio in digging groundwater wells is greatly improved if the locations of well sites are based on geophysical surveys. The institute has been carrying out groundwater exploration through resistivity surveys almost since its inception. Its researches are not merely of theoretical interest, for its results have already found successful application. For example, consequent on an unprecedented drought situation in Maharashtra and Madhya Pradesh, the NGRI mobilized 25 field parties in 1972 and recommended well sites for many villages. Again the institute rendered such technical assistance to the Government of Maharashtra during the 1983 drought.

Instrumentation

The direct-current resistivity meters used by the institute in groundwater surveys have been designed and fabricated by its own instrumentation group. In addition, about 200 meters have been supplied to various user organizations such as universities, government departments and private prospectors. The technical know-how for manufacturing the resistivity meters has also been transferred to a private company, Elico Ltd, Hyderabad, which has so far supplied scores of units to various customers.

Programme of Ground Water Research

The Lower Manar Basin, in Warangal and Karimnagar districts of Andhra Pradesh, was selected by NGRI as a pilot basin for multi-

disciplinary integrated investigations under an Indo-German collaboration project. Surface hydrological studies in the basin have been carried out by the Ground Water Department of the Andhra Pradesh government. The Central Ground Water Board has carried out hydrogeological surveys and has drilled wells at a few selected places. The NGRI has carried out hydrogeological and hydrochemical studies, resistivity surveys and recharge estimation through nuclear techniques. It has also prepared a coarse digital model of the shallow aquifers. Specific problems have been tackled by using a mass-spectrometer. Photogeological studies followed by resistivity profiling have been used in understanding the nature of the faults a water channels. All this has helped finalize a programme of drilling wells for exploitation of groundwater resources.

Similar integrated studies, involving photogeological, hydrogeological, hydrogeochemical and geophysical surveys, drilling of wells, pumping tests on dug wells and recharge measurements have been completed in two basins covered with the Deccan Trap basalt, located in Ahmednagar and Aurangabad districts of Maharashtra.

In addition, the institute's research facilities are being used for studying specific problems. For instance, hydrogeological reconnaisance work has been carried out in Sikkim. The tracer laboratory has undertaken recharge measurements in the Vadavati River basin, Noyil and Ponnati basins of Tamil Nadu and Kerala and the Anantapur district (Andhra Pradesh). The environmental tritium and radiocarbon laboratory has measured samples from Vedavati basin in Karnataka and Andhra Pradesh and from Pondicherry, Ramanathapuram, Neyveli and Coimbatore areas of Tamil Nadu. The stable isotope laboratory has studied deuterium:hydrogen and oxygen-18: oxygen-16 ratios in water samples from hot-springs. Digital resistivity-current analog models have been prepared for the Krishini-Hindon area U.P. Similar models are being prepared for a portion of Narmada basin in M.P. and for a granitic area in Mahbubnagar district of A.P.

All these investigations were taken up at the instance of, and in collaboration with, the Central Ground Water Board and state groundwater departments.

The institute proposes to undertake long-term integrated basin studies in collaboration with central and state government agencies.

Specific Schemes for Rural Development

Out of many R&D programmes in exploration and management of groundwater resources which NGRI has undertaken, the following specific schemes have emerged as of relevance to rural development.

Pumping test on dug wells

Groundwater exploitation in villages is characterized by large-diameter dug wells, which are unique to our country. The number of such dug wells could be of the order of about ten million.

The performance and capacity of wells are tested through controlled experiments involving pumping tests (No satisfactory methodology was available earlier for conducting such tests in large-diameter dug wells). The institute has developed a cheap, constant-discharge device, and has used it for successful completion of such tests using the pumping system.

Groundwater survey (top) using electrical resistivity meter and follow-up drilling in field on a recommended point (bottom).

Rain-water harvesting

The western coast of the country and the foothills region of the Himalayas are characterized by heavy rainfall in monsoon but meagre surface or groundwater resources in summer months. A feasibility report for harvesting rain-water on a laterite-covered plateau at Malvan on the west coast has been formulated. The work will involve construction of water-proof trenches for storing irrigation water and development of a horticultural farm on a patch of land which is barren at present. This work is to be carried out in collaboration with the Centre for Application of Science and Technology for Rural Developmnt, located at Pune.

Artificial recharge through in-tank wells

The central and southern parts of country are covered with hard rocks and receive inadequate rainfall. Percolation tanks or small-size irrigation tanks are used in villages in such areas for augmenting water supply. One of NGRI's on-going research schemes envisages construction of infiltration wells inside these reservoirs for recharging

the groundwater aquifers. The tank water will be cleaned through filtration beds and allowed to recharge the groundwater system for a period of 3-4 months during monsoon.

The pilot scheme is planned in Medak district of Andhra Pradesh in cooperation with Ground Water Department of A.P. during 1984 monsoon.

Optimal utilization of water resources

This programme involves utilization of the limited precipitation in a small agricultural watershed in a semi-arid region through evaluating the performance of the existing percolation tanks and wells and installation of additional tanks and wells on the basis of a scientific study. Water-harvesting experiments are also planned. This work will be carried out in collaboration with the International Crop Research Institute for Semi-Arid Tropics located at Hyderabad.

The research facilities established at NGRI are aimed at development of groundwater resources of the country through an integrated multidisciplinary approach. It is dovetailed with the exploration and development programme of the Central Ground Water Board and state-level groundwater agencies. This also involves development of methodologies for augmenting rural sector water supply.

APPENDIX 1.: SELECTED STATISTICS AND INDICATORS FOR RURAL AND URBAN INDIA

S.No.	Item	Year	Unit	Rural	Urban	All-India
1.	Population					
	a. Total	1981[a]	million	502	156	658
	b. Percentage	1981[a]	%	76.3	23.7	100.0
2.	Density	1981[a]	per km²	161	2,743	221
3.	Decennial growth	1961-71	%	21.9	38.2	24.8
		1971-81[a]	%	19.0	46.0	24.4
4.	Literacy rate (including	1971	%	23.7	52.4	29.4
	0-4 age group)	1981[a]	%	29.6	57.2	36.1
5.	Sex ratio	1971	Females per	949	858	930
		1981[a]	1000 males	954	880	936
6.	Economic dependency rate	1981	%	153.5	218.4	166.4
7.	a. Percentage of Scheduled Caste population to total	1971	%	16.1	8.8	14.6
	b. Estimated Scheduled Caste population	1981	million	86.3	13.1	99.4
8.	a. Percentage of Scheduled Tribe population to total	1971	%	8.4	1.2	6.9
	b. Estimated Scheduled Tribe population	1981	million	45.8	2.1	47.9
9.	a. Percentage of workers	1971	%	34.0	29.3	33.1
	(main) to total population	1981	%	34.8	29.2	33.4
	b. Total workers (main + marginal)	1981	million	198.0	49.0	247.0
10.	Av. household size	1971	persons	5.5	5.2	5.4
11.	Crude birth rate	1980	per 1000 population	35.0	27.6	33.5
12.	Crude death rate	1980	do	13.7	7.8	12.5
13.	Infant mortality rate	1979	per 1000 live births	136	70	125
14.	Av. age at marriage for females	1971	Years	16.7	19.2	17.2
15.	Consumer expenditure per person per month	1977-78	Rs	75.6	108.7	—
16.	People below[b] poverty line					
	a. Number	1979-80	million	259.5	57.3	316.8
	b. Percentage	1979-80	%	50.7	40.3	48.4
17.	Estimated unemployment	1981	million	17.5	4.5	22.0
18.	Labour force[c]	1981	million	193.0	50.2	243.2
19.	Percentage unemployment in labour force	1981	%	9.1	9.0	9.0
20.	Net domestic product	1970-71	%	68.2	31.8	100.0

a. Excluding Jammu & Kashmir and Assam.

b. The poverty line is defined as the level corresponding to a consumer expenditure of Rs 76 per capita per month in rural areas and Rs 88 in urban areas.

c. Excludes the age group of below 15 years.

Source : Rural Development Statistics (National Institute of Rural Development, Government of India, Hyderabad 500 030), October, 1983.

Subject Index

(Only technology entries are used in index preparation. The numerals are those appearing before the technology titles in the text.)